

FINAL

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# INDUSTRIAL MODERNIZATION INCENTIVES PROGRAM

## PHASE II: AUTOMATED QUALITY ASSURANCE SYSTEM

### FINAL REPORT

PREPARED FOR  
AERONAUTICAL SYSTEMS DIVISION  
WRIGHT-PATTERSON AFB, OH 45433

CONTRACT NUMBER F33657-86-C-2024

JUNE, 1989

TELEDYNE CAE

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**FINAL REPORT**

**APPROVAL**



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INCENTIVES PROGRAM**

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## FOREWORD

This final report covers work performed under Contract F33657-86-C-2024 from September 1986 through January 1989. The contract with Teledyne CAE (TCAE), Toledo, Ohio was performed under the "Industrial Modernization Incentives Program" (IMIP). This program was funded through the Propulsion System Program Office in the Aeronautical Systems Division (ASD/YZD) at Wright Patterson Air Force Base and administered under direction of Major Dale Clary and Captain Sarah Tandy.

IMIP at TCAE was administered by Mr. Robert Beck. Mark Claudio was the Project Engineer directly responsible for the Automated Quality Assurance System (AQAS) effort under direction of Mr. Sanjay Swarup. Technical direction was provided by Mr. Lynn Blair.

ITP boston, Inc. was the subcontractor responsible for design analysis, detailed design, construction and demonstration of AQAS. The AQAS project was managed at ITP by Albert Hopkins, initially, and the effort was completed under management of Matthew Keith.

This document is published under Teledyne CAE Report Number 2403 and describes the final design and lessons learned from the Phase II effort. Major portions of this document were written for TCAE by ITP boston, Inc.

## CHAPTER 1

### EXECUTIVE SUMMARY

This report describes results of the Phase II Automated Quality Assurance System (AQAS). AQAS is a project conducted by Teledyne CAE under the Industrial Modernization Incentives Program Contract Number F33657-86-C-2024.

Teledyne CAE is an experienced leader in the field of small military gas turbines, having produced over 16,000 small engines for the US military. The company is devoted exclusively to the small engine market. Teledyne CAE is the World's leader in producing turbine engines for tactical missiles and RPV's, and ranks second in turbine engines for targets and strategic missiles. Teledyne CAE has two production engine divisions: one in Toledo, Ohio and one in Gainesville, Georgia.

AQAS is a computerized quality assurance system for input, storage, and analysis of quality and inspection data. As lots of parts travel on the factory floor, quality operation instructions can be viewed, inspection data entered on serialized and unserialized parts, gage calibration checked, and statistical process control charts viewed. The AQAS system contains controls ensuring that quality instructions have been followed.

AQAS was designed and constructed by ITP Boston, Inc. The Phase II system runs on a MicroVax, and is written in Fortran 77 with calls to a relational data base (Ingres, Relational Technology, Inc.) and graphics software (DI3000, Precision Visuals, Inc.).

AQAS can accept measurement data from a keyboard, digital gages, analog gages, an in/post-process grinding gage, files created by a coordinate measuring machine and a probe file created by a numerically controlled machine retrofit with a probe.

This report describes the design developed through the Phase II effort along with suggested enhancements for a production AQAS system. A preliminary cost/benefit assessment was performed based on estimated Phase III costs and benefits foreseen in full scale production.

## CHAPTER 2

### AQAS OVERVIEW

This chapter presents the AQAS System Concept, followed by an overview of the AQAS System.

#### 2.1 SYSTEM CONCEPT

Inspection records of product acceptance are contractually required for Mil-I-45208 and Mil-Q-9858A based systems. These records are labor intensive in their creation, use in process analysis, storage, and retrieval, and further, are subject to loss, damage and illegibility. A compelling need exists to replace obsolete, shop paper systems with modern computer aided quality data systems. The new system will not only simplify the development and collection of such data, but will provide access to that data for use by all organizations in defining process capabilities and drawing requirements.

AQAS is an Automated Quality Assurance System designed to record and process measurement results from the factory floor using, in part, data supplied to it from other computer systems. The recording of results is simplified by a variety of data gathering systems. Any measurement discrepancies are identified to individual parts, and tracked until they are resolved. Software tools are provided to perform within-lot and between-lot statistical process control using data gathered from the factory.

AQAS is a Phase II "IMIP" project. Phase II is a prototype demonstration of AQAS technology at Teledyne's Toledo facility. Upon successful completion of Phase II, and if there is a favorable ROI, Phase III will be initiated, which involves implementation in both the Toledo and Gainesville facilities.

Figure 2-1 reproduces the original TCAE proposed system model.

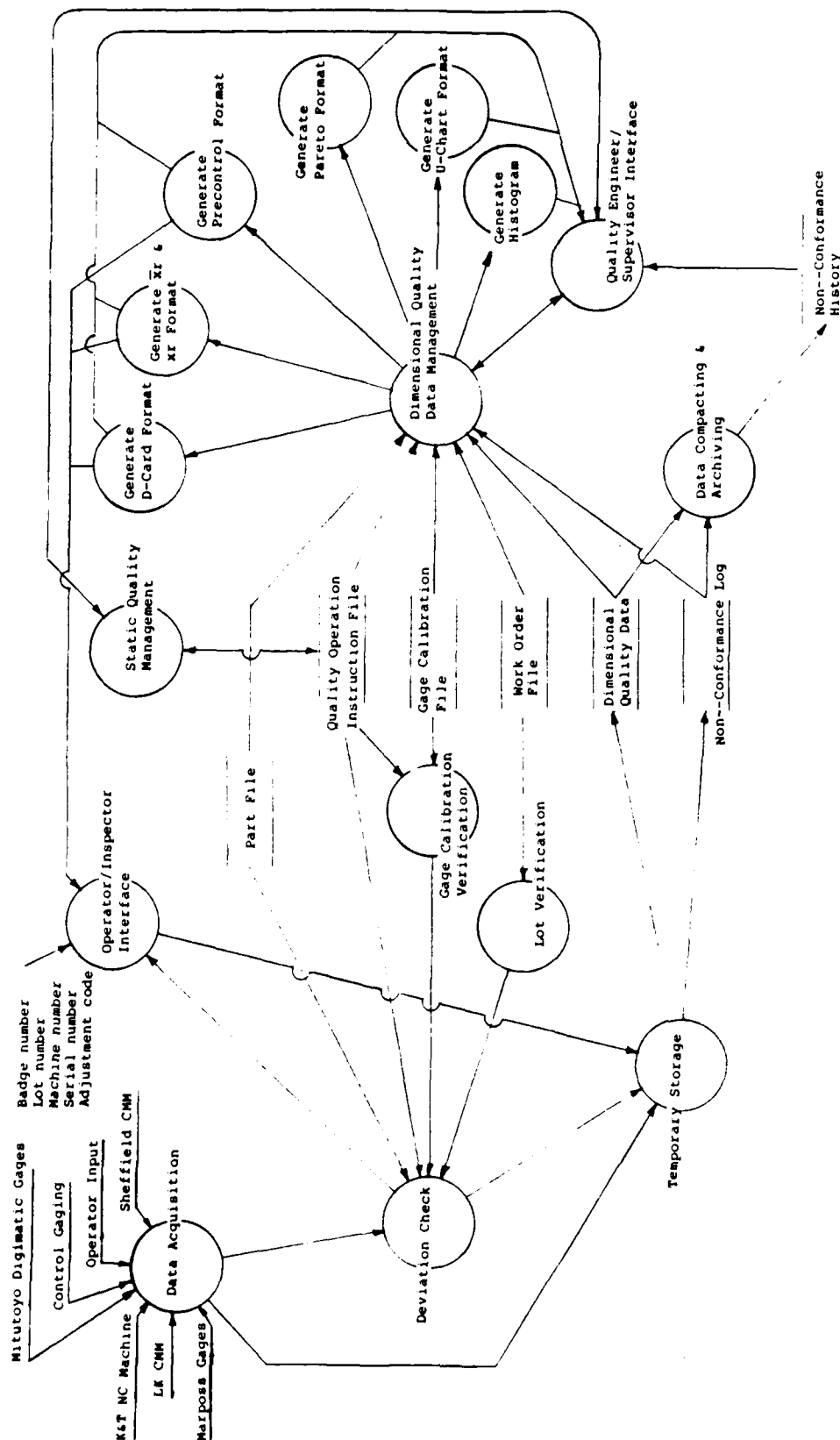


FIGURE 2-1 - LOGICAL MODEL OF THE AQAS SYSTEM

The principal goals for the AQAS system were met and described below. Detailed information on how the goals were met is provided in the references.

- o Provide systematic tools for analysis of quality data generated on the factory floor. For the operator, Statistical Process Control capability is a tool to uncover changes that affect part quality before out-of-tolerance parts are produced. For the quality engineer, a plant-wide analysis of quality problems can be performed, so that attention can be focused on problems where the most benefit is to be gained (ref. 4.4.7 and 4.4.8).
- o Be usable with the external computer systems existing in both the Toledo and Gainesville environments. AQAS will operate in the VAX environment using the VMS operating system for Toledo and Gainesville. AQAS will interface with the IBM 3033 plant system which contains quality operation instructions, lot information and gage calibration data. These two factories, with different computers and operating procedures, must be accommodated as easily as possible. In addition, there may be other opportunities within Teledyne to use the technologies developed in AQAS (ref. chapter 5).
- o Automate as much of the data gathering as possible. The intent is to increase the accuracy and ease of obtaining measurements from the factory floor. In addition, part-by-part automated measurement on the K&T machine is performed, with the opportunity to perform SPC calculations on each part produced in this automated unit.

Automated data gathering requires receipt of data from:

- . Mitutoyo Digital hand-held gages
- . Marposs E4 Analog column gage
- . Marposs or Control Gaging (on grinding machines) gage
- . LK coordinate measuring machines
- . Kearney and Trecker NC machines
- . Keyboard input

Automated data gathering is referenced in chapter 6.

- o Create records of non-conforming parts that require resolution of their non-conformance before part lot processing can continue. All deviated parts are acknowledged, and are either repaired, scrapped, reworked or disposition deferred before the next quality specific operation can begin. In addition, AQAS links inspection data to specific parts where there are non-conformances or serial numbers. Creation of non-conforming part records is referenced in 4.3 and resolution is referenced in 4.4.
- o Eliminate paperwork specific to quality inspection operations. This will keep information current and improve the control and the coordination of information on the factory floor (ref. 4.3.11).
- o Ensure data integrity. Data integrity applies to the correctness of the data (data entry checks), identifying the user with the data as it is recorded, preventing the loss of recorded data, and securing portions of the data base where classes of users are restricted from



modifying or entering data (ref. 4.1).

- o Be expandable into a plant-wide system. Although AQAS is funded as a demonstration project, the software is designed to transition to a production/larger system as easily as possible. Plant computer system interfaces are referenced in chapter 7
- o Perform in a user-friendly fashion, particularly where operators and inspectors have intensive interaction with the system (ref. 4.1).

## 2.2 SYSTEM OVERVIEW

### 2.2.1 Constituent Elements

The Phase III production implementation of AQAS is seen as being separate systems in the Toledo and Gainesville plants. Each AQAS system will have a central computer (in the VAX family) which maintains the AQAS data base for that plant, and which is responsible for the aggregation and archiving of quality data. A simplified system interface structure is shown in Figure 2-2.

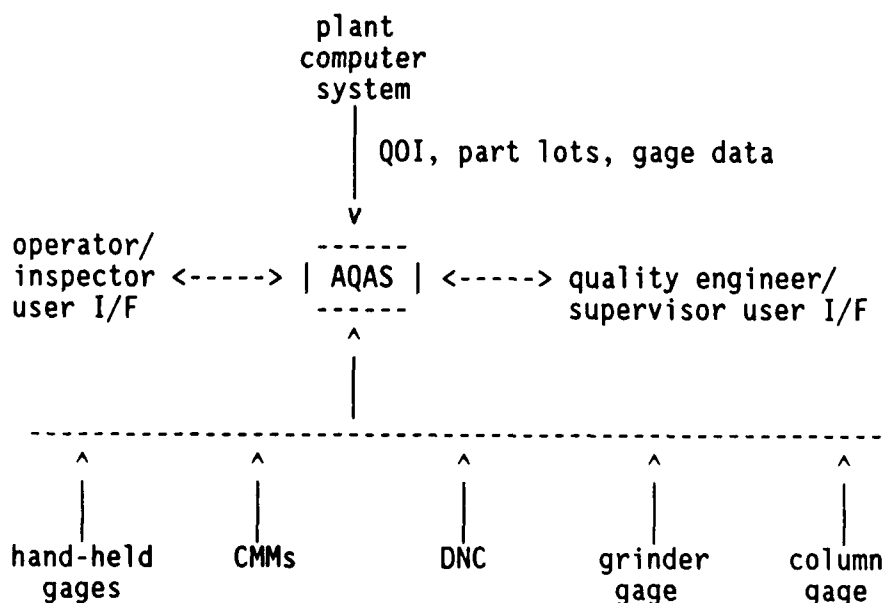


FIGURE 2-2 - AQAS INTERFACES

The systems will be protected against the outage of any single electronic element by means of redundant data storage and processing elements.

The phase II feasibility system will have several work stations which will interface with one or more of the following:

- (Mitutoyo) hand-held gages
- one CMM (an L-K, teleprocessed from Gainesville)
- one (K&T) machining center
- one Marposs E4 column gage
- and one grinder (a CM step grinder, teleprocessed from Gainesville).

The software created for Phase II will cover the basic functionality needed for Phase III.

### 2.2.2 Production Overview

Orders from customers result in the creation of work orders on the Plant Computer System. Each work order includes a listing of operations to be performed to complete the work order. The listing of operations is built from a Master Routing for the work order's Part Number. The Part Number may refer to the Engineering Drawing Number for the parts to be manufactured.

A Fab Order Routing is issued to the floor for each work order. The Fab Order Routing is the paper copy of the work order along with a list of the operations required to complete the work order.

Each operation has a quality and/or production component. For those operations with a production component, an OSO (Operation Sequence Outline) procedure contains details about the operation. For those operations with a quality component, a QOI (Quality Operations Instructions) contains details about the quality procedures required.

The first operation on the Fab Order Routing is the assignment of "raw material" to be used to complete the work order. The raw material is tracked as the "part lot" for the work order. Depending on the work order, the raw material may be assigned serial numbers to allow "part item" tracking.

For each quality operation, an "inspection lot" defines those part items that have completed an operation under the same production conditions. Quality requirements are defined for the inspection lot. An inspection lot may contain more or less than a single part lot.

### 2.2.3 User Interfaces

User interfaces will be provided for Operators, Inspectors, Quality Engineers,

and System Managers. Operators and Inspectors will interact with AQAS from the work stations and other data sources on the plant floor. Quality Engineers will additionally have office access to the system. The Systems Manager will be able to access the system from any location.

User interfaces will have color graphics capability, and will have interactions prompted by specialized screen software. The need for user training will be minimized by the familiar "menu" structure of the screens for each type of user. Data security will be enhanced by login and password protection.

## CHAPTER 3

### FUNCTIONAL REQUIREMENTS

The functional requirements described in this chapter reflect the design as it stood at the end of the Detailed Design phase of the development of AQAS. Additional requirements agreed to during construction of AQAS are detailed in chapters four through seven.

The functional requirements for AQAS are presented in this chapter, which consists of the following sections.

- o First, an overview of the current procedures is presented.
- o Second, an overview is presented of the functional areas with which AQAS is involved. This section is primarily concerned with the data collection functions. Once the data is collected, it is available for the Quality Engineer functions. The Quality Engineer functions are discussed in Chapter 4.
- o Third, a typical scenario for completing an operation's QOI instructions is presented, along with the proposed operation scenario at a work station.
- o Support Procedures include all those procedures not covered specifically under the data collection procedures.

#### 3.1 REVIEW OF CURRENT OPERATIONS AND PROCEDURES

In order to make the AQAS system the best quality assurance system possible within the given constraints, we have started with an overview of current inspection procedures. Primarily, the Toledo plant is used as a model to gather this data. The Gainesville plant is used as a model when discussing the LK CMM.

- Determine the baseline functional requirements of the AQAS system. This includes functions to be incorporated in the AQAS system, and functions to be omitted.
- Determine possible features that the new system should strive to provide.
- Provide a starting point for comparing the differences between the Toledo and Gainesville plants.

### 3.1.1 Overview From A Quality Perspective



There are two distinct information sources for the operations that occur at a work station where quality inspection is required: production instructions and quality instructions. Production instructions are required for all operations performed on a lot. Quality instructions are required only at those operations where data is gathered to guarantee that production is meeting product specifications.

The production instructions and procedures include the following:

- Fab-Order and Fab-Order Routing
- Operation Sequence Outline (OSO) Procedures
- Part Lot and Split Lot Handling
- Serialized and Non-Serialized Part Handling

The quality instructions and procedures involve a combination of both production instructions and procedures, and the following items:

- QOI Plan - Quality Instructions
- QOI Revision Log
- D-Cards - Recording quality measurements
- Inspection Lots
- Non-Conformance and MRB Handling

As quality and production are strongly inter-related, the above divisions, in reality, overlap in several areas.

#### 3.1.1.1 Creation Of The Quality Plan Using The QOI System

A quality plan is required for each part number/operation that has a quality component. The quality plan for the part number/operation is referred to as the QOI for the part number/operation. The QOI contains the characteristics for which inspection data must be recorded.

Currently, the QOI is maintained in the QOI Subsystem on the IBM 3033. The part number must already be known to the system. The operation number in the QOI plan is not required to exist in the current master routing (table MR) for that part number.

Not all operations on the Fab-Order Routing have a corresponding quality operation in the QOI file.

Changes to the QOI for a part number/operation are logged in the QOI Revision Log. This log is used to record actual changes to the QOI plan, and to record acceptance of new operating procedures (OSO revisions) against current QOIs.

#### 3.1.1.2 Operation Sequence Outline (OSO) Procedures

The OSO procedures are issued to the factory floor for each part/operation and kept in a file cabinet at each work center. New releases have new OSO revision numbers. The OSO operating procedures contain detailed instructions - including graphics - about the specific operations to be completed.

The OSO includes identification of those characteristics where quality measurements are required.

#### 3.1.1.3 Creation Of A Part Lot Work Order

A Work Order is created when the scheduling system determines that there is a requirement for X items of a certain part number.

The Work Order contains the routing information for the part. The routing information is obtained from the Master Routing file for the part number. The Fab-Order sheet and Fab-Order Routing sheet are then issued for the part lot.

The first operation on the Fab-Order Routing is the assignment of physical parts to the work order.

#### 3.1.1.4 Issuing The Fab-Order And Fab-Order Routing

The Fab-Order is manually issued. It is basically a cover sheet for recording specific information about the part lot.

The Fab-Order Routing is issued by the IBM 3033 from the part lot work order. The Fab-Order Routing contains the operations that must be completed on the part.

The Fab-Order Routing accompanies the part lot on the floor from one work center to another, and is used to record the completion of the various operations. The Fab-Order Routing is then used to enter the completion of operations into the scheduling system. The entering of these completed operations into the computer is often done by a dispatcher after several operations have been completed.

As the lot is processed, any required changes to the routing for the particular lot are entered onto the Fab-Order Routing.

#### 3.1.1.5 Handling Of Serialized Parts

When a work order is created requiring X number of parts, the physical parts are assigned to the part lot as the first operation on the Fab-Order Routing.

The assignment of the serial numbers to the lot (if the part lot uses serialized parts) may be done as part of the first operation on the Fab-Order Routing or it may be done at a later operation.

One example of why the assignment of serial numbers might be delayed is where the initial material is a bar, which is later cut into several pieces. The serial numbers can not be assigned until the bar is cut.

At the time the serialized number is assigned to a specific part item, the following information is recorded manually:

- Heat Lot Number (if it applies).
- For Assembled part items, the serial numbers for those items that make up the newly assembled part.
- Vendor Serial Number

This may also be used as the serial number of the part at Teledyne.  
This number must be unique within part number.

In the cases where the vendor had a unique serialized number for the part item, the vendor's serial number may be used as Teledyne's serial number. In this case, no additional information needs to be entered to trace the serialized part item.

The operation at which serial numbers are to be recorded is listed on the Fab-Order Routing.

#### 3.1.1.6 Issuing Quality Operations To The Factory Floor

The D-Card forms are generated through the QOI system. These forms are issued to the appropriate work centers for future use. The D-Cards reside in cabinets on the factory floor for use by operators and inspectors.

For every part/operation, D-Cards are printed which list the characteristics requiring measurement. A D-Card contains the following information:

- o Part Number and Operation.
- o Department Number.
- o QOI Revision.
- o Headers for each Characteristic of the part which must be measured.

The QOI revision on a D-Card is used to check against the QOI Revision log to ensure that the OSO Revision is usable with this D-Card's QOI revision.



### 3.1.1.7 Operator's Use Of The Fab-Order Routing / QOI Plan

The Fab-Order Routing, also referred to as the traveler, lists the actual

operations to be performed on the part. As operations are completed, the operator will record their completion, the quantity of parts that was in the part lot at the beginning of the operation, and the quantity of parts at the end of the operation.

The size of a lot can change, either because the lot has been split, or because part items in the lot have been scrapped. Lots are split because of non-conformances or for production related reasons.

At each operation, the following must be addressed:

- . Recording of Inspection Results
- . Handling of non-conformances - if they occur.
- . Handling of Split Lots - if the need arises.

Each operation on the Fab-Order Routing has a block which indicates if there is a quality plan for this operation. The OSO contains the quality characteristic codes and appraisal codes, plus additional information required about an operation. The operator checks the OSO to determine if D-Card entry is required.

The Operator at the work center accesses the current OSO revision for that part/operation. The OSO write-up is kept at the various work centers where required.

For the first part machined, the operator has a basic check list of requirements. Many of these 'first part requirements' require the participation of an inspector or quality supervisor.

- o Verify QOI version.

The OSO revision of the process instructions must be an allowable OSO revision for the current quality instructions. This is checked manually by the inspector using the QOI revision log, which compares the current QOI Revision (listed on the D-Card and in the QOI revision log) against the OSO revision (listed on the OSO Operating Procedures and the QOI revision log) and the OSO listed on the Fab-Order Routing.

If it is not an allowable combination, the quality supervisor is called to reconcile the differences between the Quality revisions and the OSO revision. Processing of the part can not continue until this is resolved.

- o An inspector has to be available for any first part inspections, tool control, die control or fixture control.

These requirements are listed in the QOI.

Currently, the Inspection results are recorded using the D-Card form, which is printed from the QOI system. All data is entered manually. The details of the inspection process are covered in a later section.

#### 3.1.1.8 Handling Of Non-Conformances

Problems with the results are reported by the operator, and verified by the Inspector.

Upon verification of the problem, a non-conformance is logged onto the back of the Fab-Order Routing. If the problem is not verified, a Quality Supervisor is called in to determine the next action.

Processing of the part lot does not continue to the next operation until a Preliminary Material Review (PMR) of the non-conformance has been completed. The purpose of the PMR is to classify the non-conformance.

A splitting of the lot may be done at the time the PMR is classified, or as a pre-cursor to classification to allow the rest of the part lot to continue on to its next operation.

The classifications for PMRs are:

- SCRAP - Problem parts are removed from the part lot to be scrapped. The scrapped parts are assigned a Scrap Tag Number.
- VOID - Problem parts turn out not to be a problem at all. The non-conformance is marked as "void".

- Continue-In-Process - Problem part items will be corrected by upcoming standard operation procedures. In this case, the non-conformance is closed - and the part lot in its entirety can continue on to the next operation.
- Deferred - The non-conforming part items are given deferred dispositions. These parts require special handling and/or inspection at a later operation. These parts are generally not split off from the parent lot, but can be if it is convenient for either production or quality reasons.
- MRB - Problem part items not correctable through one of the above actions require MRB (Material Review Board). The parts (and their lot) can not continue processing until the MRB is cleared or the MRB parts are split from the lot. MRB parts are assigned Non-Conformance Material Review (NMR) Numbers when the MRB is opened. One NMR number may apply to one or several parts in the part lot.

In summary, a new operation can not begin on a part lot that has active non-conformances against any of the parts in the part lot. The active non-conformances must first be resolved via a PMR (and possibly an MRB action) or the non-conforming parts must be split from the part lot.

As part of the PMR step, the part lot may enter a wait state if problem part items can be easily and quickly fixed. The part lot goes into a wait mode while the problem parts are being worked on. Once the problem part(s) are worked on, one of the above classifications is chosen for the problem parts.

#### 3.1.1.9 Handling Of Split Lots

Lot Numbers, which consist of 4 characters, are assigned when the work order is created. When a lot is split, the number of parts in the parent lot is decreased, and a new lot is created. Its number consists of the 4 characters from the parent lot plus a 'sublot code'.

The split is recorded against the parent lot on the FAB-Order sheet. The information recorded about the split includes the number of items split off from the parent lot, the operation where the split occurred and the serialized parts which were split off from the lot.

Split lots are entered into the IBM system, and result in new work orders being created. The information entered into the IBM is basically the split lot number and the number of parts in the split lot. No checking is done to guarantee that the actual number in each lot is correct.

New operations for the split lot are recorded manually on the Fab-Order Routing. Then, a copy of the old Fab-order Routing is made for the new split lot to maintain the history of the lot before the split occurred. The parent lot continues to use the original Fab-Order Routing. The production related Fab-Order changes are entered into the IBM system at a later time.

#### 3.1.1.10 Inspection Lots

An inspection lot is defined to consist of all parts/operations which meet the following criteria:

- Part Number and Operation Number are the same.
- Machine Number is the same.
- The machine has not been interrupted from producing the part/operation.
- The fixtures for this operation have not changed

A number of checks are required at the start of the inspection lot, all of which are indicated in the QOI. If a first-piece inspection is required, an Operation Release card is used to record the first-piece inspection and its success or failure. The first piece must be approved according to the inspection procedures (as shown on the QOI plan for that part number/operation) before the next part can be produced as part of the inspection lot. If the first piece is not approved, the next part must be inspected and a new operation release number is assigned.

1. Operation Release Cards The Operation Release card is used for operations with a first-piece release specified on the QOI plan, as well as, for spot checks within an inspection lot.

Information recorded on the Operation Release card includes the following:

- Part Number
- Operation Number
- Part Name
- Process Revision Number
- Lot Number
- Lot Quantity
- Department
- First Piece Serial Number (If serialized)
- Operator Number
- Inspector Number
- Approved (Yes/No)

### 3.1.2 Detailed Overview Of The Quality Inspection Procedure

The focus for this discussion is the procedures and interactions for the operator and the inspector as they relate to the quality system.

#### 3.1.2.1 Manual Gaging During Production

Manual gaging is performed on most of the operations where the shape of a part is modified. This gaging is performed by the operator and/or the inspector. The operator is responsible for most inspection, while the inspector is responsible for the correctness of the measurements. In practice, the latter is performed by auditing. A few critical items are watched very closely by the inspector.

All information for manual gaging is obtained from paper and all measurement data generated during an operation is written to paper (the current D-Card).

1. The Part lot begins an operation by being delivered to a work center with the appropriate paper work and tools accompanying it. This includes:
  - . Fab-Order and Fab-Order Routing (comes with the Part Lot).
  - . OSO Operating Instructions (available at work center's file cabinet).
2. The Fab-Order Routing indicates if an inspection record is required for this operation. Those operations with an x in the inspection field on the Fab-Order Routing do not require recording of inspection results. However, many in-process checks are made by the operator that are not recorded by the Quality system.

If inspection recording is required, the following must be available at the work center:

- . QOI Instructions (comes with the tool delivery or already at work center).
  - . D-Cards (already available at the work center).
  - . QOI revision log (available on computer only).
3. The work order quantity is listed on the Fab-Order, and this is entered on the Fab-Order Routing for the first operation as the "Quantity in". From then on, the operator enters the quantity in and the quantity out for each operation, verifying their accuracy each time.

4. The Fab-Order Routing lists the OSO revision for each operation. This revision number is related through the QOI log to an acceptable QOI revision number for the operator. This QOI revision number is then used to check that the D-Card and the QOI instructions are correct for this operation.
5. Gages required for inspection are listed for the operator on the QOI. Some gages required are kitted at the tool crib and delivered from the crib for operator use at his/her work location. Other gages are resident at the work location. Still other gages are "owned" by the operator (commonly referred to as "personals").
6. An inspector is called over, who verifies the calibration of all individual gages before the operation begins. Currently this is done by checking the dated labels on the gages.

Any gages that require calibration are delivered back to the tool crib and exchanged for another equivalent gage. If an equivalent gage is not available, the inspector can select an alternate gage listed on the QOI which is within calibration. All gages listed on the QOI can measure with sufficient accuracy.

If neither option is possible, the original gage may be calibrated and authorized for use by the Quality Engineer/Supervisor. Failing all of the above, a Quality Engineer/Supervisor can authorize a different gage to be used. It is the Quality Engineer/Supervisor's responsibility to authorize only those gages that can take readings to the correct accuracy.

There is a difference between incremental and absolute gage readings that the operator and inspector must take into account. In many cases, the same gage can be used both ways, and there is no way to tell from the result how the gage was used.

7. Any special information about this operation (as a result of actions that occurred before this) is written on the Fab-Routing. The inspector and/or operator consults with production or quality supervision to determine the additional requirements for the operation.
8. The operator writes all of the serial numbers in the batch onto the D-Card(s) for this operation if he is entering results for all part items in the part lot.

The inspection instructions for operator and inspector are listed as a two-character alphanumeric code on the QOI, known as the appraisal code. Values for the first digit of the appraisal code can be one of the following:

- X, Manual control
- L, Tool control
- D, Die control
- F, Fixture control
- T, Computer/Tape control
- R, Release control
- S, Special Instruction control
- G, Process Capability control
- C, Chart control

In all cases, except codes 'X', 'G' and 'S', the QWI states that something (the first article, fixture, die, etc.) is to be checked before starting the operation. Code 'X' requires a "minimum of 100%" inspection, and this is interpreted as all parts are checked and the information is entered onto a D-Card. 'S' characteristics require reading the QOI information supplied, for the characteristic, which provides a textual description of the inspection to be performed. Code 'R' requires the last piece to be checked in addition to the first piece.

The second digit of the two-character appraisal code determines the inspector's requirements for recording of inspection results. The rules for the operator in the inspection area are determined by the first character alpha-code, often in conjunction with instructions in the QOI (or OSO).

The D-Card is used by both the operator and inspector for recording inspection results.

Codes for inspector audit are:

- 0, no audit required
- 1, 1 in 5 audit required
- 2, 1 in 10 audit required
- 3, 1 in 15 audit required
- 4, 1 in 20 audit required
- 5, 100% audit required
- 9, Audit required per Q.E. instruction

9. The first article inspections are listed by code "R", and the operator uses these to get "buy-off" of the first part. Currently, "F", "L" and "T" also require first article inspection, but this will change in the future.
10. An inspector audits the operator's first article inspection paying particular attention to audit codes "L" (tool control), "F" (fixture control), "D" (die control), "R" (release control, first and last piece), "S" (special control defined in the characteristic description field on the QOI), and characteristics with an audit level of 5 (100%) and 9. An inspector's audit is the recording of his/her stamp if the inspector and operator agree, or a new value with his/her stamp if they disagree.

An inspector can not change the operator's measurement entry as part of normal procedure. If the operator's measurement is wrong, the quality supervisor is contacted, and the operator is instructed to retake the reading. In the case where the operator is no longer available, the Quality Supervisor can permit an inspector to re-record the operator's results. This is done very infrequently.

11. The operator continues production, recording those measurements specified by the QOI. The inspector audits the on-going operation results as per the QOI requirements. The inspector can audit during the processing of the part lot, or can wait until the operator is finished processing the lot.
12. Some actions are performed at the end of an operation. At a minimum, non-conformance reports are written to the back of the Fab-Order Routing.

An operation is not finished unless all parts are processed and all results recorded for that operation. The preceding operation must be completed before a new operation can begin. This means that, before a new operation starts, all parts in the lot must have satisfactorily completed the preceding operation, unless they have been scrapped or split from the lot. All QOI requirements for the previous operation must be complete before the next operation can begin, as evidenced by a complete set of operator and inspector measurements.

#### 3.1.2.1.1 Manual Gaging With Marposs Or Control Gaging

The Marposs gage is used as an in-process gage that displays measurement differences on an analog meter. It is used on a grinder. The zero set point on the analog meter is easily changed with a small potentiometer on the front of the gage box.



In practice, the Marposs gage is not used to measure to absolute standards, but is used as an in-process check of the diameter of the product. A column gage and a master are used to actually confirm the dimension of a part produced by the grinding machine. The operator uses the potentiometer to dial out the variance between the Marposs and the master based on the measurement of the part on the column gage.

A master is a calibrated piece of known dimension made of a substance that does not change dimension over time (due to corrosion, wear, etc). The master is too small to be used directly in the Marposs gage itself. Because of thermal expansion, the master must be kept in a basket surrounded by coolant of the same temperature as the grinding machine, and is only removed to make a measurement.

After the initial (or set-up) adjustment, the Marposs is adjusted whenever the operator "feels" that the Marposs gage is beginning to wander. There appears to be an expertise acquired over time that helps the operator decide when to do this. However, the determinant of the dimension of the part is the column gage and master.

#### 3.1.2.2 Automated Gaging With The LK CMM

The LK Coordinate Measuring Machine (CMM) is operated in the Gainesville facility. Physically, the facility is in a temperature controlled room where parts are delivered to be inspected. The CMM is controlled by a MicroVax computer with one RD53 hard disk drive. It appears that the LK MicroVax is the smallest configuration that exists, and that the software on the MicroVax, both LK and DEC supplied, is a minimum level with the fewest available features.

Parts and paperwork are usually delivered manually and one-at-a-time to the CMM room. This is because the production volume is not large enough to require the delivery of whole lots. The parts are placed on a workbench for a period of time to temperature stabilize, though the operator may not necessarily know when the part has arrived. This is not a constraint, again, because the production volume is low.

The operator takes the part with its paperwork and gets a quality inspection sheet blank from paperwork in the room. The paperwork lists all the measurements that are to be inspected and has spaces to log the results. Next, the CMM operator logs onto the MicroVax computer and is entered immediately into the CMM controlling program.

The CMM application program is very limited in its functionality. It allows the user to manually run the CMM using a set of joysticks, select a part program, run a part program, and stop a part program in progress. There is no room for expansion within the LK software, so future applications should be added as a "shell" over the LK CMM software.

The first stage of running a part program is to correctly set up the part on the table using gaging blocks and manual, joystick movement of the CMM. A part program is then selected by typing in the part number, and using this part number as the name for the part program. The selected part program is then run.

As the part program runs, instructions are displayed to the operator. All outputted results are displayed on the VT220 terminal and also printed on a line printer in the CMM room. As the inspection proceeds, the operator writes the results onto the quality inspection paperwork. In a few instances, the line printed results are sufficient, and these are used instead of the hand-written quality results.

Results are printed out in an LK format that identifies the x, y, z coordinates of touches, and displays results from calculations of these touches as directed. Results are labeled based on information supplied in the part program and printed out on the terminal/line printer. Output can be traced to an inspection drawing that numbers the characteristics to be measured. Sometimes, the part program outputted results are not given a characteristic number but are titled by the type of measurement (O.D., I.D., etc.) and the allowable tolerances - which requires thorough knowledge of the inspections being performed, and the part geometry involved in the inspection.

### 3.2 AQAS FUNCTIONAL AREAS

The following sections describe the functions performed by AQAS. These functions are carried out by the user interface and procedures detailed later in this document. The major functional areas include:

- QOI Master
- Part Lots
- Parts
- Inspection lots
- Non-Conformance and MRB Handling
- Quality Engineer/Supervisor Analysis

### 3.2.1 QOI Master

The QOI is created on the plant system and is downloaded to the AQAS system via flat files. The QOI Master is not modified by AQAS except when processing QOI changes received from the plant system.

The QOI Master contains detailed information about a specific part number/operation [PNO]. This detailed information includes

- Characteristic Data - Details about the measurements to be performed by the operator/inspector during this part number's operation.
- Revision Log - Means for checking the current QOI revision against production.

#### 3.2.1.1 QOI Revision Control

AQAS is responsible for ensuring that the current QOI plan is an approved plan for the current operation revision. This will be done by requiring the operator to enter the OSO revision, which is checked to ensure that the current OSO revision is an acceptable revision for the current QOI revision. This check is made at the beginning of each inspection lot.

### 3.2.2 Part Lots

There are two types of part lots:

- . Original Part Lots  
AQAS is informed of original part lots via downloads from the plant computer system.
- . Split Part lots  
AQAS is informed of split lots via user input.

Part lots and split lots are processed in the same way. The difference is in how they are initially created. Duplicate part lots are not allowed in the AQAS system.

A part lot is identifiable by part and lot numbers. A part lot initially consists of a part number and the quantity of parts assigned to the part lot to fulfill a work order.

Requirements for part lot tracking in AQAS have been defined as follows:

- o A part lot may have only one quality operation active at a time. This means the current operation must be completed before the part lot can begin a new operation.

The following are required for a part lot to be considered complete:

- . Minimum QOI data entry requirements for the operator are met.
  - . Minimum QOI audit requirements for the inspector are met.
  - . All questionable results are resolved.
  - . All non-conformances and MRBs for parts in this lot have been resolved.
- o The QOI operations performed on the part lot must be done in a sequential order.

#### 3.2.2.1 Split Lots

As a part lot goes through production, it may be split into several new lots. In this case, the parent lot is retained as the first four characters of the new part lot number, and a sequence number is appended.

For example, the splitting of the parent lot "J201" will result in lot numbers such as "J201-01" and "J201-02". A split lot may be split again but must always maintain the parent lot in the first four characters.

AQAS is informed of the splitting of part lots when the operator/inspector identifies a split lot via a user interface. The operator will be required to enter the following information about the split lot:

- o Split Lot Number (ex: J201-04)
- o Immediate Parent (ex: J201-02)
- o Quantity of part items
- o Serial Numbers of the Part items (if serialized parts) or optional non-conforming part identifications (if non-serialized parts)

A report will be provided by AQAS that lists split lot information. This report can be used to cross-check information maintained on the plant computer system.

The Plant System will not inform AQAS of split lots. This decision was made because AQAS requires additional information about the splitting of the lot not available on the Plant System and because AQAS needs to handle split lots on an immediate basis.

Creation of split lots by AQAS includes the following:

- o The immediate parent lot is modified for the split to have an adjusted number of current part items.
- o Quantities of parts are accounted for across all newly created split lots and the immediate parent lot.
- o The new split number is unique within AQAS.
- o The notepad information for operations yet to be performed are copied to the new split lot, if requested.
- o Non-conforming part status is carried over to the split lot (if there are non-conforming parts in the split).
- o All measurements made on serialized parts are carried to the new split lot

- o Measurements made on non-conforming, non-serialized parts marked for the operation at which the split occurred are carried to the new split lot

Once split lots are created, they are processed the same as the original part lot.

### 3.2.2.2 Part Lot Procedural Modifications

Modifications to the procedures for a specific part lot are made via the use of a notepad. The notepad will inform the operator/inspector of a particular condition of the part lot. Whenever the part lot is introduced into an operation, the notepad for the part lot is presented to the operator/inspector for review. This approach allows the part lot specific information to be relayed between operations.

Any problem parts identified via procedures outside the QOI master are handled under the 'general workmanship' procedure.

### 3.2.3 Parts (Serialized And Non-Serialized)

AQAS supports the recording of measurement data for serialized and non-serialized parts. Part lots are considered non-serialized until the operator/inspector enters into AQAS the serial numbers for the part items in that part lot. There are two reasons for this: 1) this approach eliminates the need for AQAS to know which parts require serialization and 2) this approach eliminates the need for AQAS to know at which operation the serial numbers are assigned.

It is possible that the requirement for the operator entering serial numbers into AQAS may be replaced in the future by another system.

#### 3.2.3.1 Serialized Parts

AQAS is responsible for recording measurement data against serialized parts, once they become serialized. Recording of Serial numbers in AQAS has the following requirements:

- o Serial Numbers Must Be Unique within Part Number.

Serial numbers are assigned external to AQAS, and entered into AQAS by the operator. AQAS checks serial numbers entered by the operator for uniqueness within other known serial numbers for the same part number.

- o A part lot is all serialized or all non-serialized

Once the operator elects to enter serial numbers for the part lot, all items in the part lot must be assigned serial numbers.

- o Assembled part information.

Parts that are assembled from other parts can be assigned a list of part numbers/serial numbers. It is required that these part serial numbers (known as "component serial numbers") that make up the assembly be recorded. An additional check has been requested to ensure that a part serial number is used a maximum of one time as a component of an assembled part.

Unserialized component parts can have heat code information entered for the serialized assembly part. Allowance is made for the entry of more than one heat code, within a single component part number, assigned to a single final assembly serial number. AQAS maintains a count of each unique part number/heat code component entered as part of the assembly serial number.

- o Vendor or serial information for each serialized part may be entered.

For each serialized part, heat lot number information for a particular serialized part can be entered at the same time as the serial number for the part is entered.

Other requirements include entry of one of the following, as selected by the operator:

- . Vendor Serial Number

The vendor serial number will be checked for uniqueness within part number. The Vendor Serial Number may be the same serial number used by Teledyne.

. TCAE Serial Number

AQAS does not contain any information to determine the vendor or source information that needs to be entered for a specific part number. The operator will determine the information, if any, that needs to be recorded when the serial number is entered.

The AQAS system records measurements against serialized parts, not against the lot, once the parts are assigned serial numbers. Likewise, AQAS records non-conformances against specific serialized parts.

3.2.3.2 Non-Serialized Parts

AQAS is responsible for recording measurements for the lot as a whole where non-serialized parts occur. Measurements against non-serialized parts are traced only by the part lot; they can not be traced back to a specific part within a part lot.

Heat code information can be entered for an unmarked part lot. This information must be the same for all parts within the lot.

If an unmarked lot with heat code information is serialized, all heat code information is transferred to the individual parts in the lot.

If non-conformances occur, they require assignment of an identifying unique number for the specific parts involved. The number is unique within the part lot/operation where the non-conformance is generated. AQAS will display a number when the questionable measurement is entered (or a non-conformance is created in the case of an inspector) that will be marked on the part.

3.2.4 Inspection Lots

The inspection lot contains data specific to the production process of the operation. Within an inspection lot, the QOI related data may change. For example, a gage may be replaced without starting a new inspection lot. Inspection lots are defined as continuous production runs that may cross part lot boundaries. Inspection lots begin and end independently of part lots.



Between part lots, AQAS requires that the operator identify whether an inspection lot is being continued, or a new inspection lot has been started. Within a part lot, it is the operator's responsibility to determine that a new inspection lot has been started.

A new inspection lot shall be started if any of the following changes occur:

- Part Number and/or Operation Number Change
- Machine Number Change
- Fixture, Tool or Die change
- Production of a part number/operation is interrupted.  
For example, a temporary interruption due to plant shut down or due to another part number/operation at the machine.

Inspection lots are identified internally in AQAS.

The requirement for first article inspection is defined by the characteristics in the QOI plan for that part number/operation. First article inspection requires that an inspection be performed on the first part in the inspection lot before the second part can be processed.

The first article inspection may involve measuring several pieces to obtain a first piece release.

At minimum, first article inspection for R control code characteristics is required. Other possible characteristic codes may require first article inspection based on a table contained in AQAS and maintained by the quality engineer/supervisor.

Statistical process control calculations for the current inspection lot are available to the operator and inspector.

#### 3.2.4.1 Inspection Lot Procedural Modifications

Modifications to the official inspection lot procedure may be made for any inspection lot, but exist only while the inspection lot is active. Modifications allowed for the inspection lot include:

- Accept an OSO revision number not in QOI revision log.

- Allow alternate Gage number(s) to be used for a characteristic.
- Change maximum/minimum dimensions for a characteristic.

Any such modifications shall be recorded with the measurement data. The quality supervisor/engineer privilege is required to make the above modifications.

#### 3.2.4.2 Measurement Lots

Measurement lots are created internally in AQAS to allow quality measurement data to be grouped within an inspection lot. The measurement lot is an internal AQAS grouping of data to allow for more efficient access of data for quality engineering purposes.

#### 3.2.5 Non-Conformances And MRB

Non-Conformances are recorded by the inspector when a problem with a part item is identified. The problem may be due to measurements taken or caused by 'general workmanship' (i.e., the inspector visually identifies a problem).

If an operator records a measurement that indicates a problem, the part lot and specific part are marked as 'questionable'. The inspector is required to raise the status from questionable to non-conformance on agreement with the operator.

All parts labeled as questionable must be audited by the inspector.

If the measurements are conflicting, the quality supervisor is required to resolve the difference. A conflict is defined as a measurement or attribute which when taken by one person is in tolerance, and when taken by the other is out of tolerance. At this time, the operator or inspector may retake the measurement or the quality supervisor may authorize the taking of the operator's measurement by the inspector.

There is a requirement that a part lot must complete its current quality operation before it can begin a new quality operation. A part lot is not considered complete if there are any unresolved non-conformances in the part lot. In the AQAS system, the resolving of non-conformances involves classifying the non-conformance in one of the following ways.

o Release the Non-Conformance

This option may require that a complete set of measurement results for those characteristics which generated the non-conformances be entered (screening the lot), unless a complete set was already taken. The non-conformance can be lifted for one of the following reasons:

- . Void the non-conformance.  
A void is used when the reason for the non-conformance was not valid.
- . In-Process  
The problem will be addressed due to machining in future operations.
- . Rework  
The part was reworked, and the problem was fixed.
- . MRB Acceptance  
This option is only valid for MRB parts. It indicates that the part can continue production.

o Defer the Disposition

The non-conforming parts are allowed to continue processing. The non-conformance will be addressed at a later operation.

o Split the Lot, and place non-conformances into a new lot.

The non-conforming parts are split from the lot, and handled separately. The non-conformances are removed from the parent part lot and the operation can be completed. The split lot is not marked complete because the parts require further dispositioning.

o Return To Vendor

The defective parts are removed from the lot to be returned to vendor. These parts are given an MRB status, and split from the lot.

o Scrap the part.

The defective parts are removed from the lot, and the part lot operation is marked complete. This entry may require the inputting of a corresponding Scrap Tag Number.

Resolving non-conformances requires the quality supervisor/engineer privilege.

The assignment of the MRB status to the part requires an NMR (Non-conformance Material Review) number be entered.

### 3.2.6 Quality Engineer/Supervisor Analysis Option

The statistical process control calculations can be performed at the discretion of the engineer/supervisor, with use of additional facilities for data selection. The most important single item of note is that calculations are performed across inspection lots. This allows selection of inspection lots by applying a sorting criterion. The available sorting criteria for a specific PNO and characteristic are:

- By specific machine
- By date range for inspection lots
- By specific operator

In addition, Pareto charts can display categories of various data types. The use of these charts applies to:

- Number of non-conformances by machine
- Number of non-conformances by part number
- Number of non-conformances by lot within a part number
- Number of non-conformances by cell or work center

### 3.3 QOI OPERATION SCENARIO

The AQAS system supplies the operator with the appropriate procedures to perform the required inspection for a QOI operation. This set of procedures operates on the "current operation" for a work station.

The standard set of procedures provided by AQAS are:

- o Operation Identification (defines the current operation)
- o Part Lot Identification (defines the current part lot)
- o Review of Special Instructions (notepad)
- o Gage Validation
- o Collecting Data

Figure 3-1 shows an overview of the operator/inspector user interface.

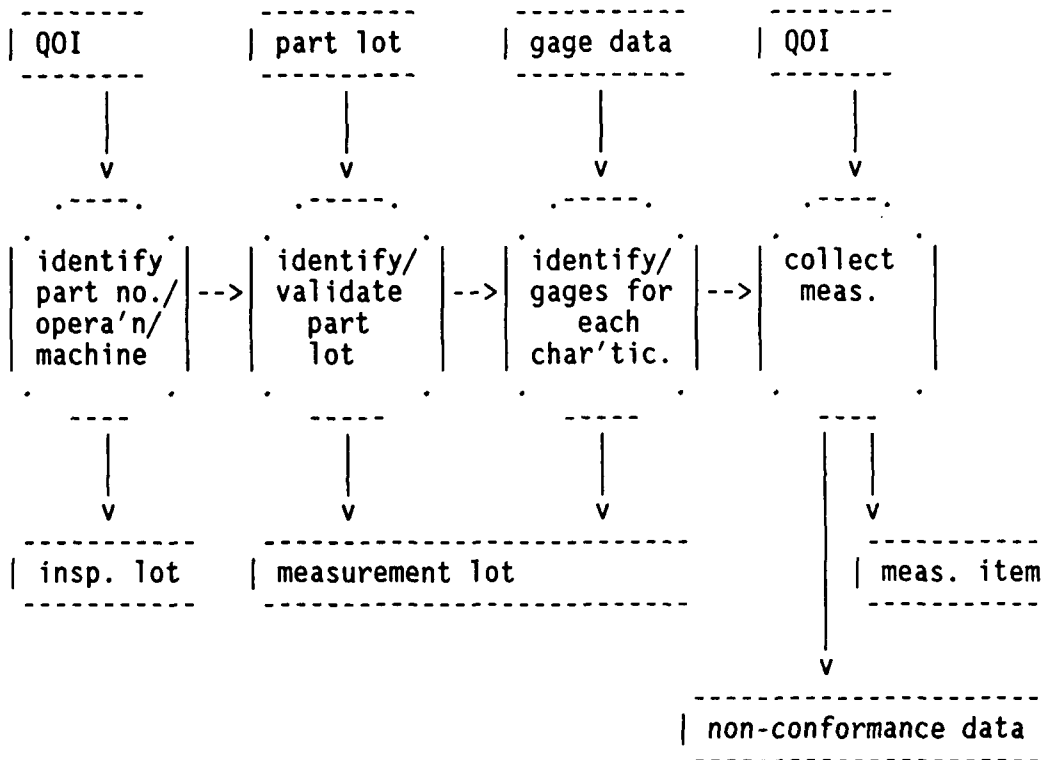


FIGURE 3-1 - OPERATOR/INSPECTOR DATA COLLECTION PROCEDURE

### 3.3.1 Operation Identification

This procedure is used to start the inspection for a specific part/operation and initiate the current work session at the work center.

The operator is instructed to enter the following data:

- . Part Number - Validated against the AQAS Part Number table.
- . Operation Number - Validated against the AQAS QOI table.
- . Machine Number - Currently not validated.
- . Badge Number - Validated against an AQAS Employee table.
- . OSO Revision - Validated against the AQAS QOI table.

After entering and validating this information, the AQAS system creates the work session for this operation.

In most cases, errors can be corrected by reentry of the information. In a few cases, correction may require invoking another procedure. For example, the correction for a lot number that is not found may require a split on another lot.

### 3.3.2 Part Lot Identification

Part Lot Identification is required at the beginning of the inspection lot, and as subsequent part lots are processed within the inspection lot.

The procedure for introducing a new part lot includes the following:

- o Review Previous Part Lot for Completion.

During an Inspection lot, the operator will finish one part lot and begin the next. At the time the operator requests to start a new part lot (or requests to exit the inspection lot), AQAS checks the status of the current part lot to determine if it has completed its operation. If it has not, AQAS displays messages to indicate the required actions necessary to complete the part lot's operation.

There is no control to prevent the operator from proceeding with the next part lot and/or inspection lot. However, the part lot will leave its current operation marked as incomplete.

- o Identify the New Part Lot.

The operator is instructed to enter the following data:

- . Part Lot Number - Validated against the AQAS Work Order table.
- . Part Lot Quantity - Validated against the AQAS lot table.

Checks are made to ensure that this is a valid part lot for the current inspection lot, and that the operation being performed is a valid one for the current part lot.

If the part lot entered had been started previously, the measurement results already taken for the part lot are made available.

A notepad exists for each part lot which allows the operator to review special instructions for the part lot. When a new part lot is introduced, the instructions in the notepad are displayed to the operator for review. Included in the display will be the comments entered, who entered them, and the time and date of entry. This is referred to as the "notepad" for a part lot.

### 3.3.3 Gage Validation

Gages which are used in the manual gaging area must be checked to ensure that they have not passed their calibration due date.

The gage procedure is initiated for the following reasons:

- Inspection Lot is being started
- Operator indicates change in gages to be used

Operators can elect to use new gages as required anytime during the data collection procedure.

- Current Gages have reached their 'calibration-due date'.

Periodically, AQAS checks to determine if it is a new day. If it is, the gages currently being used in the inspection lot are checked to determine if they have reached their calibration due date. If they have, the operator is instructed to re-identify the gages to be used for the inspection lot. This does not require a new inspection lot to be started.

Primary gage types are displayed, as well as any substitute gage types that can be used. The user will then enter the unique serial number of each gage chosen for use. Note that there is no checking of the QOI gage type in AQAS. The checking of gage types is not done because it is not kept in synchronization with the tool, gage, and fixture system.

The checking of gage types may be required in the future. The design of AQAS considers this future enhancement.

As each gage serial number is entered, the AQAS system will check to ensure that the serial number exists, and that the gage's calibration due date has not been reached. If it has, another gage of that type will have to be selected.

A valid gage serial number, either primary or alternate, must be entered for every required gage.

Options for entering a gage serial number include the following:

- Entry of another serialized gage of the same gage type
- Selection of an alternate QOI gage type in lieu of the primary gage type.
- Change of the calibration date for an individual gage if it has been recalibrated and the new date has not been downloaded to AQAS from the corporate gage system. Note: this option will require the quality supervisor privilege.
- Alteration of the gage type required for the current operation and specific characteristic. This action does not alter the QOI information in AQAS, and is unique for this inspection lot. Note: this change will require the quality supervisor privilege.

When the serialized gage has been accepted for a characteristic, results for that characteristic can begin to be collected.

The collection of measurement results varies depending on the devices used to take them and the procedures in the QOI plan.

### 3.3.4 Collecting Data

The serial number of the part being inspected is entered if the parts in the lot are serialized. A given QOI plan may require receipt of results via one or all



of the following methods:

- Keyboard entry - the operator moves to the character code of interest and keys in a number or an attribute result (+, -, 0). The type of result (measurement or attribute) depends on a QOI record / verify field.
- Gage entry - the operator indicates that a hand-held digital gage is going to be used and takes the measurement electronically.

The operator will have specified whether the readings are absolute or delta.

- File read - the operator indicates that measurement results are available on a probe file. The device to which the file belongs will have been specified at the beginning of the inspection lot. The file will have a standard name. The results are then read into the AQAS inspection and recorded in the data base to prevent loss. This is the appropriate procedure for the LK CMM and the K&T Milling Center.

An operation may require the receipt of probe data, from the K&T for example, with more results entered by the operator for the same part.

In some cases, hand-held gages and keyboard entry gages are used in an offset mode where the number entered is a difference reading that has to be converted to absolute for comparison to QOI information. In these instances, an option field on the data capture display exists for entry of the offset value. The value in this field is automatically added to the measurement result displayed on the screen.

There are two types of measurements: Record and Verify. Record type of measurements require that the exact measurement be entered for a characteristic. This exact measurement is compared against allowable limits to determine if the measurement is in or out of tolerance. Verify requirements require a yes/no or go/no-go entry for a characteristic.

The quality measurements, whether taken through manually controlled gages, operator input to the terminal or via interfaces to other machines, are displayed to the operator and inspector. When the result is entered, AQAS checks measurements against the QOI limits and highlights unacceptable values. The user then determines the action which he wishes to take based on the results. His options are:

- Accept the measurement by making no changes.
- Retake the measurement.

#### 3.3.4.1 Operator Collection Of Results

There are several options that the operator can use, and all may be used within the same operation. The last result obtained for a given character code is the one held and accepted by AQAS. Therefore, results read in on file can be changed with keyboard entry, and vice versa.

Any measurements by the operator which were not in tolerance result in a questionable status for that part/measurement.

#### 3.3.4.2 Inspector Collection Of Results

The inspector's audit requirements from the QOI appraisal code will be displayed upon request. Any questionable results created by the operator must also be reviewed by the inspector.

All inspector audit information must be entered before the operation can be completed. The audit can be performed at any time while the operation is progressing. A premature operation complete request by the operator will inform him/her of the need for the audit to be completed.

AQAS determines that the operator and inspector agree on a measurement if both have specified that the measurement is in tolerance [or both have specified that the measurement is out of tolerance]. An exact match on the record type measurements is not required.

#### 3.3.4.3 Exiting From Data Collection

The user can exit from the data collection portion of the operation at any time during the operation. Exiting marks any unacceptable results as questionable if the user is an operator, and as non-conforming if the user is an inspector. Parts that are out of tolerance and that are unserialized must be physically marked, and the mark recorded in the data collection display - unless it has already been recorded.

Exiting from the data collection does not necessarily indicate that the operation is complete. Also, in cases where the QOI data collection requirements have not been met, more data can be collected later at the discretion of the operator - possibly at a different terminal.

### 3.4 SUPPORT PROCEDURES

AQAS provides a number of support procedures, both for supporting operations and for maintaining the computer system. Most support procedures require the employee's privilege to be validated.

The support procedures to be supplied by AQAS include the following:

- o Quality Displays
- o Display and resolution of non-conformances
- o Archival Procedures

#### 3.4.1 Quality Displays

These displays are available for the operator or inspector during the entire operation session. They display instructions or status, but are not used to control or enter data.

- Display of the quality plan  
The quality plan (QOI information) for the current operation is displayed for operator and inspector use. This display gives an overview of each characteristic requiring measurement and all corresponding QOI information. It can be called at any time during the current operation. It does not include prints or sketches.
- X-Bar and Sigma Chart  
This display shows an x-bar and sigma chart produced for the current inspection lot. The calculations for x-bar and sigma are performed and displayed in a graphical format. A system-wide subgroup size is used which is controlled by the quality engineer/supervisor. This is called from the data collection screens.
- Moving X-Bar and Sigma Chart  
This display shows the same information as the previous graph, however, the calculations performed are a moving average and sigma calculation using a system-wide subgroup size that is controlled by the quality engineer/supervisor. This is called from the data collection screens.

- Precontrol Chart.

#### 3.4.2 Display And Resolution Of Non-Conformances

The resolution function is described earlier in this section. However, it should be noted that active non-conformances can be resolved at any time during an operation.

A list of active non-conformances (the non-conformance summary) is available to display the status of problem parts in a lot. This can be called at any time during the inspection procedure by any individual. A version of this screen is also provided in the quality engineer/supervisor interface.

#### 3.4.3 Archival Procedures

Procedures for archiving measurement data will be available on AQAS upon request. These procedures require the System Manager's privilege, and will be initiated manually. The procedures will be documented in the System Manual. The archival procedures will include procedures for archiving data, as well as procedures for retrieving archived data.

## CHAPTER 4

### AQAS USER INTERFACES

#### 4.1 USER INTERFACE OVERVIEW

The AQAS User Interfaces are responsible for providing the users of the system with the appropriate functions to perform their jobs. The users' interfaces must ensure data integrity, as unobtrusively as possible, and be user-friendly.

Data integrity encompasses several concepts, all aimed at ensuring that the data captured by AQAS is correct, secure, and correctly identified. The main concepts embodied by data integrity are:

- o Data Access Control  
Restricting user interface functions and procedures to certain users. Data access control is provided by organizing the users into classes. "Classes" are maintained in a domain table in the AQAS data base.
- o Data Correction  
Ensuring the correctness of the data by allowing user to review data before committing anything to the AQAS data base. This includes data entry checks.
- o Data Identification  
Identifying the data with the user who enters the information, preferably involving a positive, physical identifying technique.

It is desired that a physical method of knowing the owner of the data will be implemented in AQAS. Many methods of this control are possible, but the preferred solution involves the use of the bar code on the badges of users.

#### 4.1.1 User Classes

This section reviews the user classes in AQAS, and the general uses of classes and passwords to provide data integrity.

There are several classes of users in AQAS:

- o System Manager
- o Operator
- o Inspector
- o Quality Supervisor/Engineer

User classes are independent; an individual can belong to more than one class at the same time. Functions in AQAS require that the user performing the task or function belong to an approved class. Some functions are granted to more than one class of user, or may require additional password control procedures (see section on password control).

This is a description of the classes of users in AQAS:

##### System Manager

This user is expected to provide services other than the "usual" operation of AQAS. For example, the system manager is the only user that can change the class of another user, maintain software releases, perform backups of the data base, and maintain passwords for all users. The system manager has access to all AQAS functions.

AQAS system managers must enter passwords when they identify themselves to AQAS and are required to confirm their passwords to execute certain functions.

##### Operator

The operator is the default level of user in AQAS. His/her use of the system does not require a password, but only the entry of the badge number for associating data with the person who entered it.

### Inspector

The inspector is another class of user for AQAS. His/her responsibility is to audit measurements entered by the operator, and, in a few special cases, inspect 100% of the parts in a lot and record these measurements. Measurements are kept separately for the inspector (from the operator) even when entered for the same part and same characteristic. Inspectors are required to enter passwords when they begin to use AQAS.

### Quality engineer/supervisor

Perhaps the most powerful exercise of the quality supervisor/engineer privilege is to enact a change to QOI information on the factory floor. This may be in response to a deferred disposition or to establish a screening requirement. These changes require the supervisor/engineer privilege, and strict password control for both entry and subsequent commitment of QOI modifications.

Screening requires the privileges of the quality supervisor/engineer. Screening entails the deletion of the operator's and inspector's measurements for a currently active part/lot/operation, changing the appraisal code if necessary, followed by entry of the measurements by the operator and/or inspector.

Other restricted uses of this class are to enter non-conformance dispositions for non-conformances generated by the inspector, and to create a split lot.

Quality supervisors/engineers must enter passwords when they identify themselves to AQAS and are required to confirm their passwords to execute certain functions.

#### 4.1.2 General Use Of The Class And Associated Passwords

Every screen in AQAS will display the current user's name based on a badge number entry. Users must be instructed to change the current user name by identifying themselves whenever they begin working on AQAS. This is done by calling up an AQAS identification screen and entering the badge number and, where the class requires it, the password associated with the badge. Incorrect passwords are rejected. Passwords are not displayed when they are entered.

In certain sensitive situations, data entry may require reentry (and AQAS confirmation) of the user's password before AQAS can accept information. An example is the change of a user's password by the system manager.

With the exception of Inspectors, an individual user can change his/her password with the required badge identification and entry of the old password (to positively identify the person) followed by entry of a new password. The entry of a new password will require a double entry to verify that the password is correctly entered. If a user forgets his/her password, the system manager can create a new one, but cannot read the old password. This protects the user's password from even the system manager.

Inspector passwords are assigned by the system manager and cannot be changed by the Inspector himself. This provides the control which is present today in the Inspector stamp.

Almost all screens in AQAS will be accessible to all users for the display of information. When a restricted screen is entered, users are issued warning messages to inform them that they cannot make any permanent changes to the screen. Any changes that an unprivileged user attempts to make will be ignored by the AQAS.

In a few cases, a screen may be used by more than one user class, but the use of the screen differs for each class. In these situations, selection of a menu option not allowed for that user class will be rejected and a message will be displayed.

#### 4.1.3 Keyboard Use And Screen Design

AQAS is designed to be a user-friendly system. To accomplish this goal, careful attention must be paid to ease of use of the keyboard, and to screen design practices. This section describes features of the user interface that are consistent across AQAS, and describes the guidelines used to design the screens.

There are many different (and possibly conflicting) ways to design user-friendly systems. Among the options available are to:

1. Provide rapid movement from screen to screen using function keys. The disadvantage is that the function keys must be learned for first time users.



2. Utilize menus to move through a system. These have the advantage of providing some flexibility and guidance at the expense of extra keystrokes.
3. Guide a user from one screen (or field) to another by automatically invoking the next action. This is advantageous in that it reduces user required activities, but can be restrictive or frustrating (actually become unfriendly) when a user finds him/herself being directed into things that he/she does not want to do.

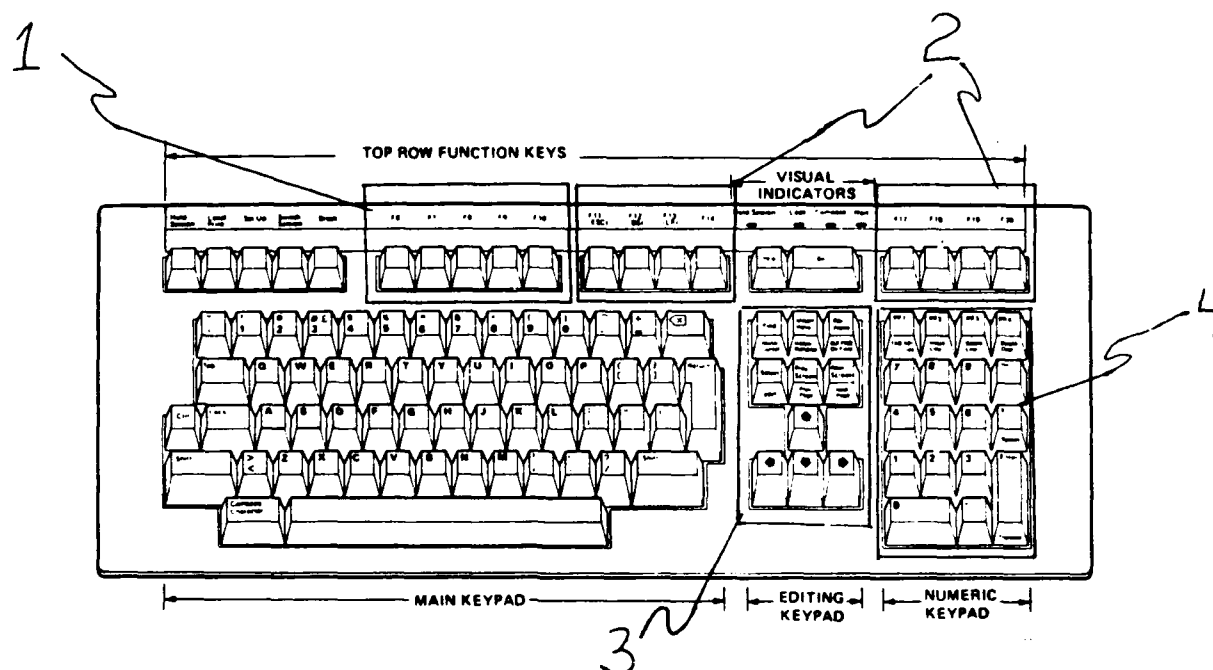
Within AQAS, all of these practices will be applied in different instances to create a user-friendly system. However, the use of function keys and automatic invocation procedures are not the most useful approaches for a flexible system like a Quality Assurance system. The use of each of the three interface techniques is described here.

#### 4.1.3.1 Function Keys

Function keys will be used for two purposes:

1. To select menu options available on each screen.
2. To perform actions that the user wants available at all times.

All keys are mapped to the VT220 keyboard (Figure 4-1). Where possible, keys that already have labels are used as their respective functions imply. For example, the HELP key is used for help information.



**Main Interaction Areas:**

1. Function Key Menu Option Select (F6-F10)
2. Function Key Action Select (F11-F20, PF1, PF2 )
3. Scrolling Area Control and Actions (FIND-Arrows)
4. Keypad Used for Entry of Numbers

FIGURE 4-1 - VT220 KEYBOARD LAYOUT

### General Use of Function Keys

The use of function keys in AQAS is based on groupings of the keys into three areas. The first group of keys incorporates the function selection keys labeled F6 through F10. These keys are used to select from the menu choices displayed on the bottom of each screen. Because only five function keys are used for menu choices, a few screens (the Operator/Inspector Data collection screen, for example) will use the keys for selecting a new menu that overlays the existing menu on the same screen. This is referred to as a sub menu, and will be clearly labeled as such: XXXXXMenu for example.

The second group of keys is the bank of function keys, F11-F20. These keys are used for common function key selections that do not vary from display to display.

The third and last group of keys is used to control the cursor in a scrolling area. These are the keys grouped together above, and including, the arrow keys: FIND through NEXT SCR. N.

Function keys are mapped as:

1. Menu Selection keys F6 through F10. The exact action of each of these keys depends on what is displayed on the menu line on the bottom of each display. The F6 (leftmost) function key is used for the next logical screen where a path is predefined.
2. Previous Display, F11. Goes back one display to the last one that the user was using. Repeated use backs the user up through the AQAS system until reaching the AQAS entry display.
3. Go directly to the Home Display, F12. The user is sent to the home display, after being prompted for confirmation.
4. Toggle Insert/Overstrike, F14. Changes the typing mode from overstrike, where a new character overwrites the current character under the cursor, to insert, where new characters are added to the screen at the cursor location. The screen is initialized to overstrike mode because new users are familiar with overstrike.
5. Help, HELP key. Can be used on any screen. This calls up the screen help information that is specific to each screen in AQAS.

6. Change user within the same display, F17. This causes the user identification display to appear where a new user can enter his/her badge and password. If no new user is to be entered, a menu choice to Cancel will be provided on the identification screen.
7. Quit AQAS and go to either the first screen, or the VMS operating system (to be determined), F18.
8. Scroll down a screen of scrolled information, NEXT SCRN. This causes a scrolled area to move down a screen's worth of information.
9. Scroll up a screen of scrolled information, PREV SCRN. This causes a scrolled area of move up a screen's worth of information.
10. Select information for copy, SELECT key. This key operates on one field of scrolled information. Within scroll entry areas, sometimes there is a need to enter one field with information and copy that line to other areas (for example, where a given gage serial number applies to more than one characteristic). This copy function is a combination of two keys: the Select key which selects a given item for copying; and Insert Here, which is used to enter the item that was previously selected. To use select, the cursor is placed in the field to be copied and SELECT is pressed. This one keystroke stores the whole field for later insertion. The user is informed that the current field is remembered.
11. Insert information previously selected, INSERT key. One field previously selected with the select information key is placed in the display at the current cursor location. The user can still edit the information after it is placed in the field with the INSERT key.
12. Target scroll, FIND key. This is used in scrolled areas to perform a target scroll. A target scroll is where a specific value from the leftmost index column in a scrolled area is directly accessed, even if it is off the current view area. The user is prompted for the specific data when the key is pressed. If the forms package accepts them, wildcards will be allowed.

#### 4.1.3.2 Guiding A User By Automatic Invocation

The general design rule for this procedure is that screens are never automatically invoked. The user decides when he/she is ready to move to the next screen by selecting from the menu options. This method of movement requires one additional keystroke per screen, but gives the user control over the pace at which AQAS moves.

Within an individual screen some automatic processing may occur as the user moves from one field to the next. This checking is dependent on the type of information being gathered and the specific application. Each screen describes the type of checking that occurs in the section of field descriptions.

#### 4.1.4 Screen Design

There are some common elements among all AQAS screens. These items are:

- Header. Every AQAS screen displays the AQAS header which consists of the AQAS system identification, the name of the display, and the date in the upper right corner. The header is followed by a blank line to separate it from the actual screen.
- Bottom line. This line is used for message display and for prompting the user.
- Line previous to the bottom. This is used for menu items.
- 2 lines prior to the bottom. The user identification is displayed on this line.

Throughout this specification, screen layouts are presented. In these layouts, entry fields are displayed with XXXX. Display fields show data that is intended to be realistic. Scrolled lines have the word "Scroll" or use arrows to indicate repeating lines.

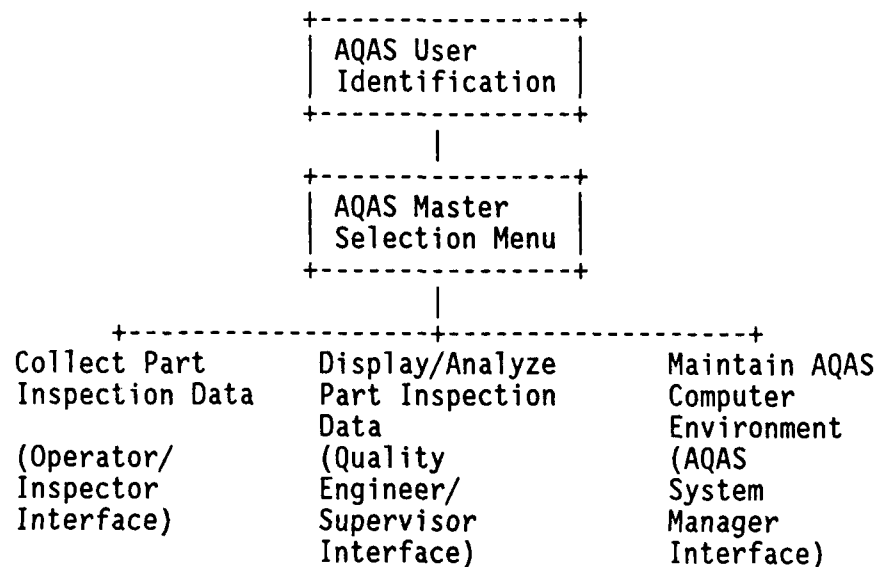
#### 4.2 USER LOGON AND MASTER SELECTION MENU

One of the fundamental requirements of the AQAS is to be able to switch to a different user within the same application screen. This is performed by the use

of a function key (described above). From anywhere in AQAS, the same logon screen will be displayed. In addition, the first screen a user of the system sees is the logon screen so that the identification of the individual is known to the AQAS.

After identifying the user, the AQAS provides a vertical menu for selection of the type of tasks that will be performed by different users. This vertical menu (Master Selection Menu) does not prevent users from going into the various branches of the AQAS. This security function is performed by the individual screens where data entry and/or modification is inhibited for unauthorized users.

Each function available from the master selection menu is detailed later on in this chapter. This is the master selection tree:



#### 4.2.1 AQAS User Identification

AQAS	AQAS User Identification	12-AUG-87
Welcome to the		
Automated Quality Assurance System (AQAS)		
If you need help at anytime while using AQAS, press the "help" key		
Please enter your badge identification: XXXXXXXXXXXX		
Enter your password XXXXXXXXXXXX		
User: John Doe		
Browse(F6)		

#### Description:

This screen is used to obtain the user's identification for use of the AQAS. It can be called up from anywhere in the AQAS, and also is the first screen encountered.

The user's badge identification can be entered by bar code or by using the keyboard. The latter entry method is to be used when the badge is unavailable.

If the user is a member of more than one class, then she/he will be prompted for the class that they wish to use when the badge identification is entered. This prompt will appear as a set of menu choices.

Fields:

1. Please enter your badge identification. 6 character badge number identification entered via bar code. Entry only.
2. Enter your password. Maximum of 12 character password entry which is NOT displayed on the screen. Entry only.

Menu Options:

1. Browse  
Allows access as a "browser".
2. Eng/Sup  
Allows access as a Quality Engineer / Supervisor.
3. Insp  
Allows access as an Inspector.
4. Oper  
Allows access as an Operator.
5. SysMgr  
Allows access as a System Manager.



#### 4.2.2 Master Selection Menu

AQAS	Master Selection Menu	12-AUG-87
X 1. Collect and Verify Part Inspection Data		
X 2. Display and Analyze Previously Collected Part Inspection Data		
X 3. Maintain AQAS Computer Environment		
Enter Selection: X		
User: John Doe		

#### Description:

This is the master selection menu for the AQAS. From here the primary purpose for using AQAS is selected.

#### Menu Options:

1. None

#### 4.3 OPERATOR/INSPECTOR INTERFACE (INSPECT PARTS FUNCTION)

This interface is used for gathering part inspection data. There are two users who are primarily expected to use this group of screens:

1. Operator

The operator collects part inspection data using the data collection screen, indicates the beginning of inspection lots, and can enter and view information on the notepad display. This is the primary interface for this user.

2. Inspector

The inspector collects part inspection data and creates non-conformance records in this interface. Inspector use of this interface is as an audit requirement for a lot previously inspected by an operator, and as an original data collection where no previous inspection occurred. The inspector has access to the same displays as the operator.

In addition, the quality engineer/supervisor user is allowed to enter the screens in this interface for display purposes, but cannot make any permanent changes.

Figure 4-2 shows the screens and links for the operator and inspector user interface:

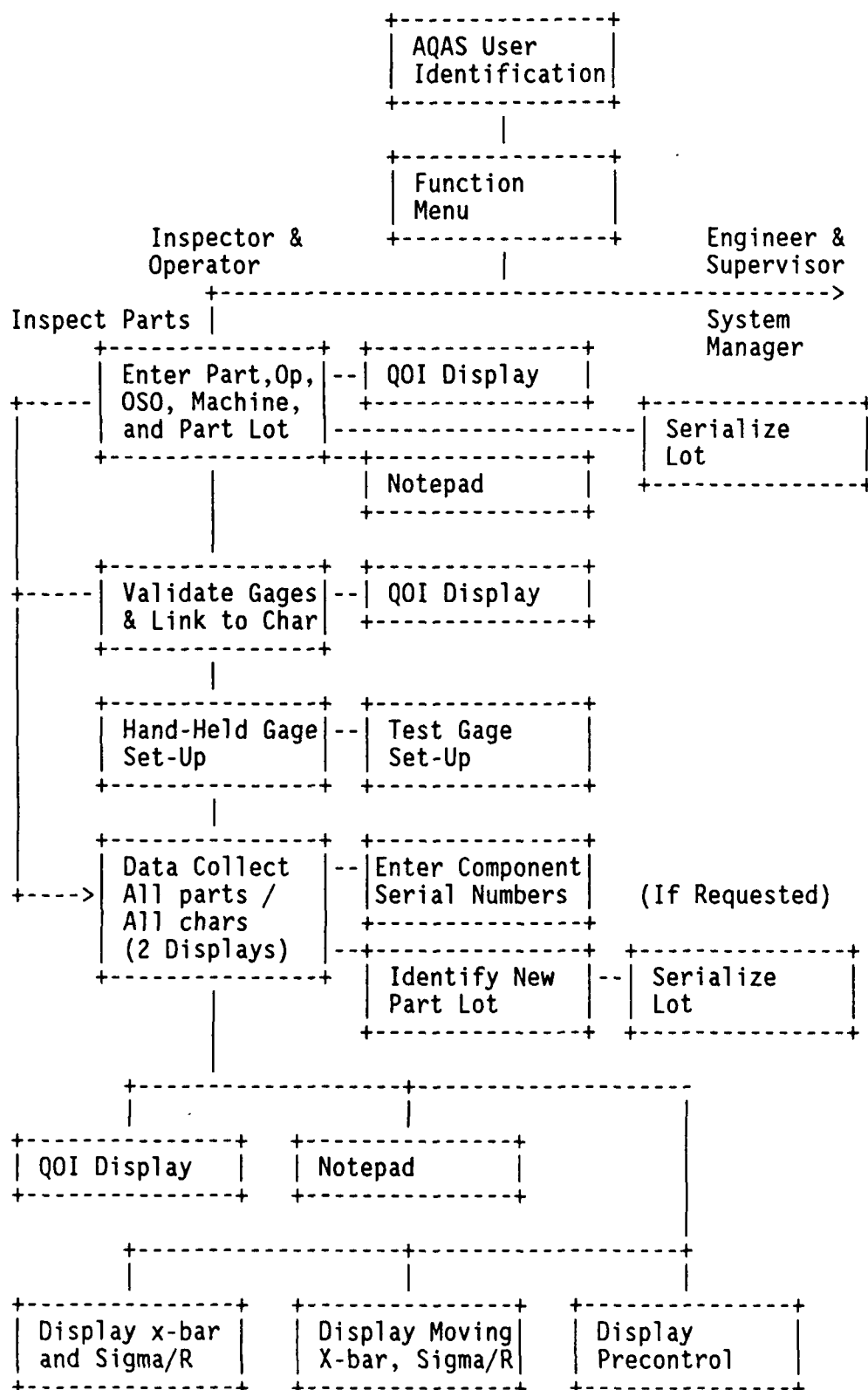


FIGURE 4-2 - OPERATOR/INSPECTOR USER INTERFACE

This user interface begins at the general AQAS identification screen (detailed elsewhere) that is the entry point into all of AQAS. The Function Menu screen (detailed elsewhere) is displayed, from which the Inspect Parts function is selected. The next screen, the Inspection Information entry, requires entry of the part, lot, operation number, work center, machine identification, and OSO information for AQAS identification and checking.

Following the lot identification, the user can go to the QOI Inspection information, Notepad, display/enter the serial numbers of the parts in the lot, declare the operation complete, or call for the inspection menu to begin/continue inspection.

After this screen, the inspector and operator reach the Validate Gages screen followed by the Hand-Held Gage Set-Up with an optional test screen for the gage set-up. Analog gages use the same set-up screen as digital gages, but include a scaling option for the conversion from volts to dimensional units.

Data Collection is the next set of screens. The operator and inspector see almost the same screens, except that the inspector has an additional display field that shows the operator measurements for the lot. The quality engineer/supervisor sees the same Data Collect screen as the inspector, but cannot enter any information. In addition, there are two data collection screens that can be used: one which allows one part to be inspected for all characteristics, and another which allows all parts to be inspected for one characteristic. The user can move freely between these two screens during the inspection process.

From the Data Collection screens, the operator and inspector can select a new part lot within the same inspection lot, view QOI Information, display and append the Notepad (same screen as previously displayed), display X-bar and Sigma chart, moving X-bar and Sigma chart, and Precontrol chart.

The rest of this section describes each of the screens in detail.

#### 4.3.1 Enter Inspection Information

AQAS	Enter Inspection Information	12-AUG-87
Enter Part Number: XXXXXXXXXXXXXXXXXXXX		
Part Description: Name of part displayed here		
Operation Number: XXXXX		
OSO Revision: XXXX		
QOI Revision: 01		
Machine Id: XXXX		
Work Center: 6 Vertical Turning Centers		
Part Lot: XXXX-XXX		
(There is information about this lot/operation in the notepad)		
(This operation has deferred non-conformances which must be resolved)		
(This lot is unserialized)		
User: John Doe		
InspMenu	QOI	Notes      Serial      OpDone

#### Description:

This screen is used to identify the current part, operation, OSO revision, and machine identification. This is the information needed to identify an inspection lot. The part lot is also identified. The user is notified if there are notes or nonconformances on the lot, if the operation is a special rework operation, or if the lot is unserialized.

#### Rework operations

Certain operations are treated differently than other operations. These operations are identified by the suffix letter "R". This letter indicates that the operation is a rework operation. For these operations, the following is executed:

- o Deferred nonconformances to this operation are retrieved from the AQAS data base.

- o The quantity of parts to be processed is set at the quantity of deferred nonconformances, even if there are more parts in the batch.
- o The list of parts produced above is used for entry in the data collection screen.
- o In other respects, the operation is carried out as if it were any other operation.

For Operators Only:

If the information entered on this screen matches the previous inspection lot data, the operator is prompted for a possible continuation of the prior inspection lot. If the operator indicates that a new inspection lot is to be started, the last piece release inspection requirements are checked to be certain they have been met before a new inspection lot can be started. If the last piece inspection requirements have not been met, the operator is prevented from starting a new inspection lot and is told to go to the data collection screen and perform a last piece release on the old inspection lot.

If there are open deferred non-conformances for this lot/operation, the operator/inspector will see a message displayed on the screen.

Fields:

1. Part Number. 20 Character entry field expected to be entered by bar code or by hand. Checked against the AQAS part number domain table. The user is informed with a message if the field does not exist and can reenter.
2. Part Description. 40 character part description displayed if a match on the part number domain table is found. Display only.
3. Operation number. One character and 4 digit operation number is entered here. Checked against the QOI operation number domain table. The user is informed with a message if the field does not exist and can reenter.
4. OSO Revision. The revision on the OSO operation instructions that the operator is planning to use. Checked against the list of acceptable OSO revisions on the QOI log. Entry only.
5. Department/Work Center. The department and work center where the work is being performed. Display field that is called from the workcenter domain table. Default from QOI information will be preplaced in the field if it exists. Display only.

6. Machine Id. The machine identification where the inspection is being performed. Checked against the AQAS machine domain table. 4 digit integer. Optional entry only.
7. QOI Revision. 2 character QOI revision which is displayed when the OSO revision is entered into AQAS and a QOI log match is found. Display only.
8. Part Lot. 4 characters followed by a 3 digit (maybe null) split number. This identifies the part lot that is going to be actively worked upon.

Menu Options:

1. InspMenu  
Brings up a submenu of choices: SetupGages, AllChars, AllParts. The user may select SetupGages to assign particular gages to particular characteristics. He may use AllChars or AllParts to move directly to data collection screens. If the inspection is just starting, the user has no choice, but MUST move to the Setup Gages display. Only valid when all entry fields have been entered and checked.
2. QOI  
Allows the operator/inspector to view the QOI information for this part, operation, QOI revision. Only valid when the OSO revision has been entered, and a corresponding QOI revision is found on the QOI log.
3. NotePad  
Jumps to the notepad user screen where comments about the part, operation, part lot are displayed and may also be entered.
4. Serial  
Calls the serialize and heat code screen where parts in the lot are given serial numbers and heat codes, or the unmarked lot is serialized.
5. OpDone  
Signifies that the part, lot, and operation that is entered is complete. When chosen, this triggers a check to guarantee that all inspection requirements have been met, and that no outstanding questionable or non-conformance characteristic(s) exist. The operator/inspector is notified of any problems and is told that the operation is not complete.

### 4.3.2 Check Gages And Assign Gages To Char Codes

AQAS		Check Gages and Assign Gages to Char Codes				12-AUG-87	
Part Number: 718371			QOI Rev: 01 Operation Number: 00042				
Char	App Cd	R/V	Gage Serial Number	Gage Type	Alt. Gage Type		
6	R9	R	XXXXXXXXXXXXXXXXXX	STD IND SETUP &	STD HEIGHT GAGE		
7	X0	R	Scroll	RDBS5080001	GDAL	G10002-001	GMAS
45	L0	R	Scroll	Scroll	Scroll		
172	M0	V	Scroll	Scroll	Scroll		
1234	M2	R	Scroll	Scroll	Scroll		
V	V	V	Scroll	Scroll	Scroll		
* Minimum:				* Maximum:			
* Sheet:		* Section:		* Zone:		* Cont Char:	
* Alt Gage 3: STD MICS				* Alt Gage 4:			
* 1) These Three lines are used to display the first three lines of the							
* 2) QOI Characteristic							
* 3) Information							
User: John Doe							
InspectMenu ListQOI LockGages ContGageLoad							

\* These lines display additional information based on the line where the cursor is located in the scrolling area.

#### Description:

Gage serial numbers are entered for each characteristic code on the QOI. The operator enters the serial number of the gage to be used in the fourth column next to the Verify/Record field. As they are entered, the serial numbers are checked against the list of valid gage serial numbers, and also the date of calibration is checked.

The primary gage, and the first alternative gage are listed in columns alongside the gage serial number. If the user wants to view the second and third alternative gages, the ListQOI option must be chosen which will display the complete list of QOI instructions.



In the case of visual inspections, AQAS accepts a standard code that appears as a "visual gage serial number", "VIS" or "VISUAL".

To facilitate the entry of gage serial numbers, the user can use the Select/Insert Here option described in the function keys description at the beginning of the AQAS User Interfaces document.

The user is not prevented from leaving this screen and proceeding to the data collection display. For those characteristics that have not had a serialized gage entered against them, data collection will not be permitted. In these cases, the on-screen gage type field in the data collection screen will display "gage not approved", and any inputted data will be ignored by the AQAS.

Fields:

1. Part Number. The part number currently in progress. Obtained from the previous screen. Display only.
2. QOI Rev. The latest QOI revision being used for this operation. Obtained from the QOI database. Display only.
3. Operation Number. One character and four digits. The operation number currently in progress. Obtained from the previous screen. Display only.
4. Char Code. The characteristic code number from the QOI plan. 4 digit integer. Scroll display only.
5. App Cd. The appraisal code for the characteristic. 3 alphanumeric characters. Scroll display only.
6. R/V. Record/Verify Indicator. Scroll display only.
7. Gage Ser Num. The serial number of the gage to be used for the characteristic code. 16 alphanumeric characters. Scroll entry and display (the latter if this is a continuation of an inspection and other gages have already been selected).
8. Gage Type. The first gage that is listed on the QOI instructions for inspecting that characteristic. 16 alphanumeric characters. Scroll display only.
9. Alt. Gage Type. The second gage listed under a given characteristic code. 16 alphanumeric characters. Scroll display only.

10. Min Dimension. The minimum dimension associated with the character code. Obtained from the QOI. 8 numeric characters including decimal point. Display only.
11. Max Dimension. The maximum dimension associated with the character code. Obtained from the QOI. 8 numeric characters including decimal point. Display only.

Menu Options:

1. InspectMenu  
Brings up a choice of the Assign Gage Port display or two data collection screens.
2. ListQOI  
Shows the QOI plan for the current part/operation/QOI revision.
3. LockGages  
Stores the gage information for use in inspection.
4. ContGageLoad  
Used to continue loading gages after one has been detected as unknown or out of calibration. The calibration check is done when the screen first appears. If gages are reused from a previous inspection, or if an inspection carries over from one day to another, it is possible that some gages have passed their calibration lifetimes. If so, loading of the gages into the screen is interrupted until this option is used to continue.

### 4.3.3 Gage Set-up

AQAS		Assign Gage Port		12-AUG-87
Part Number: 718371		QOI Rev: 01 Operation Number: 00042		
Enter the number of ports available at your station: XX				
Gage Ser Number	Enter Gage Port Number	Analog Scale	Gage Type	
STD0-1n567	XX	1.		
STD1-2n104	XX	1.		
Scroll	Scroll	Scroll		
Scroll	Scroll	Scroll		
Scroll	Scroll	Scroll		
Scroll	Scroll	Scroll		
Scroll	Scroll	Scroll		
Scroll	Scroll	Scroll		
User: John Doe				
AllChars AllParts TestGage GageType				

#### Description:

Hand-held gages which are used for automatic data entry are registered on this screen. This display obtains the information required to determine which characteristics are going to be read with a hand-held gage and which are going to be read by keyboard input; and, for hand-held gages, which port a specific gage is on.

ONLY Hand-held digital gages and analog gages for automatic data entry are selected on this screen, though the latter gage type requires the AnalogGage option. If the gage is not being read through the gage interface, then no port number is entered for the given gage serial number, and the gage port entry field is skipped.

Port numbers can be entered in any order using an integer number that is less than or equal to the maximum number of ports available at that work station.

It is desirable to use the ports in order starting from one so that unused ports will be ignored. This results in faster data collection during inspection.

Fields:

1. Part Number. The part number currently in progress. Obtained from the previous screen. Display only.
2. QOI Rev. The latest QOI revision being used for this operation. Obtained from the QOI database. Display only.
3. Operation Number. The operation number currently in progress. Obtained from the previous screen. Display only.
4. Enter the number of ports available at your station. Used to determine the number of ports that are available at this work station. This field does NOT indicate that all ports must be hooked up, only how many might be. A system-wide default value will be loaded into this field when the user enters that can be changed. 2 digit entry field only.
5. Gage Ser Number. The serial number of the gage to be used for the characteristic code. 16 alphanumeric characters. The list of gage serial numbers shows only one of each single gage serial number, even if that gage applies to multiple character codes. Scroll display only.
6. Gage Port. 2 digits, integer. The number of the gage port to which a gage is attached. All gages, up to the maximum entered in the "Number of Digital Hand-Held Gages," must be assigned. No two gages can be assigned to the same port. All character codes that use the specific serialized gage can read from the assigned gage port during data entry. Scroll entry only.
7. Analog Scale. 8 digits, real number. The scale factor assigned to a specific gage port. This option is needed only for the conversion from mV to inches (or centimeters) for analog gages. This conversion value is read from the rotary selector switch on the face of a Column Gage. Entry of the scale factor is done by selecting the AnalogGage option on the menu. Scroll display only.  
NOTE: Any required offset factor (in addition to a scale factor) is entered in the Collect Data screens.
8. Gage Type. Either Manual/Digital, StdAnalog, or PrecisionAnalog.

Menu Options:

1. AllChars  
Brings up the "All Characteristics" Data Collection display.
2. AllParts  
Brings up the "All Parts" Data Collection display.
3. TestGage  
Goes to the test gage screen which can be used to read all of the gages at the same time and display the values that would be recorded in AQAS.
4. GageType  
Prompts the user for the type of gage. This determines certain aspects of the gage setup.

Any offset for the gage is entered on the Collect Data screens.

4.3.4 Test Gage Set-Up

AQAS		Test Gage Set-Up		12-AUG-87	
Part Number: 718371		QOI Rev: 01		Operation Number: 00042	
Serial Num	Gage Type	Gage Port	Analog Scaling	Result	
STD0-1n567	Std Mics	01	1.	5.4925	
STD1-2n104	Std Id Gage	02	1.	0.3454	
Scroll	Scroll	Scroll	Scroll	Scroll	
Scroll	Scroll	Scroll	Scroll	Scroll	
Scroll	Scroll	Scroll	Scroll	Scroll	
Scroll	Scroll	Scroll	Scroll	Scroll	
Scroll	Scroll	Scroll	Scroll	Scroll	
Scroll	Scroll	Scroll	Scroll	Scroll	
Scroll	Scroll	Scroll	Scroll	Scroll	
R E S U L T : 0 . 3 4 5 4					
User: John Doe					
ReadGage					

Description:

Hand-held digital gages which are used for data entry are tested on this screen. The user can scroll through the gages and select the ReadGage option for an individual gage. The value read from the gage will then be displayed in the result column.

Hand-held digital or analog gages are tested on this screen.

Fields:

1. Part Number. The part number currently in progress. Obtained from the previous screen. Display only.
2. QOI Rev. The latest QOI revision being used for this operation. Obtained from the QOI database. Display only.
3. Operation Number. The operation number currently in progress. Obtained from the previous screen. Display only.
4. Gage Ser Number. The serial number of the gage to be used for the characteristic code. 16 alphanumeric characters. The list of gage serial numbers shows only one of each single gage serial number, even if that gage applies to multiple character codes. Scroll display only.
5. Gage Type. 20 characters. Obtained from the externally supplied gage data.
6. Gage Port. 2 digits, integer. The number of the gage port to which a gage is attached. All gages, up to the maximum entered in the previous entry field, must be assigned. No two gages can be assigned to the same port. All character codes that use the specific serialized gage will read from the assigned gage port during data entry. Scroll display only.
7. Analog Scaling. 8 character scale factor that was previously entered on the gage set-up screen. Default value of 1. Multiplied by the reading to produce the result. Scroll display only.
8. Result. 8 character real number. The reading multiplied by the scale factor. Scroll display only.
9. R E S U L T. 8 character result display field. Displays the most recent gage read in double height, double width. Display only.

Menu Options:

1. ReadGage  
Reads information from the gage port assigned and displays the result.

#### 4.3.5 Identify New Part Lot

AQAS	Identify New Part Lot	12-AUG-87
<p>Part Number: 718371 Part Description: Generic Turbine Engine Part Operation Number: 00042 QOI Rev: 01 OSO Revision: AB01 Work Center: 308917 Machine Id: 1</p> <p>Enter Lot Number: XXXX- XXX</p> <p>(There is information about this lot/operation in the notepad) (This operation has deferred non-conformances which must be resolved) (This lot is unserialized)</p> <p>User: John Doe NotePad Serialize OpDone</p>		

#### Description:

When the operator/inspector first enters this screen, the current part lot that is being inspected is displayed. If a new lot is to be inspected, it is entered on this screen over the old lot number.

The reason for this display is to provide a simple method of changing the lot number within a part number without going back to the first screen in the inspection tree.

If the new lot identified has notepad information, the operator/inspector is told to check the notepad.

If there are open deferred non-conformances for this lot/operation, the operator/inspector will see a message displayed on the screen.



If the lot is unserialized, and therefore may require serial numbers to be entered, the operator/inspector is informed of this fact.

Fields:

1. Part Number. 20 Character field which is passed in from the previous screen. Display only.
2. Part Description. 40 character part description displayed if a match on the part number domain table is found. Display only.
3. Operation number. One character and four digit operation number is displayed. Data is passed in from the previous screen. Display only.
4. OSO Revision. The revision on the OSO operation instructions that the operator is expected to use. Display only.
5. Department/Work Center. 6 characters. The department and work center where the work is being performed. Display only.
6. Machine Id. The machine identification where the inspection is being performed. 8 digit integer. Display only.
7. QOI Revision. 2 character QOI revision which is displayed when the OSO revision is entered into AQAS and a QOI log match is found. Display only.
8. Part Lot. 4 characters followed by a 3 digit (maybe null) split number. This identifies the part lot that is going to be actively worked upon. Entry only, but loaded with the last part lot that was inspected.

Menu Options:

1. NotePad  
Jumps to the notepad user screen where comments about the part, operation, part lot are displayed and may also be entered.
2. Serialize  
Calls the serialize lot screen where parts in the lot are serialized.
3. OpDone  
Signifies that the part, lot, and operation that is entered is complete. When chosen, this triggers a check to guarantee that all inspection requirements have been met, and that no outstanding questionable or non-conformance characteristics are still outstanding.

The operator/inspector is notified of any problems and is told that the operation is not complete.

#### 4.3.6 Enter Serial Numbers And Heat Code

AQAS	Enter Serial Numbers and Heat Code	12-AUG-87														
Part Number: 12345678901234567890																
Lot Number: A234- 12																
Operation Number: 01234																
Part Quantity: 50																
One Heat Code for All Parts: XXXXXXXXXXXXXXXXXXXX																
<table><thead><tr><th>Serial Number</th><th>Heat Code</th></tr></thead><tbody><tr><td>XXXXXXXXXXXXXXXXXX</td><td>XXXXXXXXXXXXXXXXXXXX</td></tr><tr><td>XXXXXXXXXXXXXXXXXX</td><td>XXXXXXXXXXXXXXXXXXXX</td></tr><tr><td>XXXXXXXXXXXXXXXXXX</td><td>XXXXXXXXXXXXXXXXXXXX</td></tr><tr><td>XXXXXXXXXXXXXXXXXX</td><td>XXXXXXXXXXXXXXXXXXXX</td></tr><tr><td>XXXXXXXXXXXXXXXXXX</td><td>XXXXXXXXXXXXXXXXXXXX</td></tr><tr><td>XXXXXXXXXXXXXXXXXX</td><td>XXXXXXXXXXXXXXXXXXXX</td></tr></tbody></table>			Serial Number	Heat Code	XXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX
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XXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX															
XXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX															
XXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX															
User: John Doe																
EnterRange LockS/N																

#### Description:

This screen is used to enter the serial numbers (and related heat codes) associated with an existing lot. Serial numbers are entered in the scroll serial number field. As the serial numbers are entered, they are checked for uniqueness against all known serial numbers within the same part number. If there are duplicates, the inputted serial number is not accepted, and a new one must be entered.

NOTE: Parts that do not have serial numbers and require identification for non-conformances are marked in the data collection screen.

If the lot already has serial numbers, no serial numbers can be modified or entered in this screen. The scrolling region will then contain the serial numbers already existing for this lot and can be used for display purposes only.

Mistakes made in entry of serial numbers can be corrected on this screen up until the time that the LockS/N option is chosen. After that time, errors must be corrected by a Quality Supervisor/Engineer, using the Change Serial Numbers and Heat Codes screen in the QE/Supervisor interface.

Fields:

1. Part Number. 20 Character display field obtained from the previous display. Display only.
2. Lot Number. The parent four character lot number and the split number are displayed from the previous screen. Display only.
3. Operation Number. One character and four digit display field obtained from the previous screen.
4. Part Quantity. Up to 6 digit display field obtained from the previous screen.
5. One Heat Code for All Parts. 20 characters. Heat code entry that either applies to the whole lot (unserialized parts) or all serialized parts. This field is inactive and the user is informed, if the lot already has a heat code or the lot is already serialized. Entry only.
6. Serial Numbers. 15 characters maximum. Standard format is AAAnnnn. Optional format: AAAnnnnA. Longer formats are possible. Scroll entry area where serial numbers are entered for the lot. If the lot is already serialized, the user is informed and cannot enter new serial numbers. Serial numbers are checked against an AQAS serial number domain table.
7. Heat Code. 20 characters maximum. Entry of the heat code to be associated with each serialized part. Scroll entry.

Menu Options:

1. EnterRange  
This option is used to generate a range of serial numbers. The first serial number is entered into the entry field on the screen. Then, when this option is selected, the user is prompted for a second serial number which is used to generate the range. The list of generated serial numbers is displayed on the screen. Generates serial numbers by recognizing the rightmost contiguous (use leading zeros as space holders where required) group of digits and using these for counting. Uses a A.n..Ann..nnA...A format by counting through the number of positions and retaining the first group of letters/numbers and the last group of letters.

2. LockS/N

Stores the list of displayed serial numbers in the data base. A warning is displayed that the lot will be permanently serialized with the serial numbers created on the display, and the user will have the option of exiting without storing serial numbers and going back to the list for more changes. Other information warnings will be printed if there are too many serial numbers, not enough serial numbers, or duplicate serial numbers.

### 4.3.7 Data Collect - All Characteristics

AQAS Data Collect - All Characteristics										12-AUG-87
Part Number: 718371				QOI Rev: 01 Operation Number: 00042						
				Lot Number: A111- 11						
				Serial Number: CT103						
Char	Apr	Cde	Port	R/V	Result	Offset	Min Dim	Max Dim	Page	Operator
0	X2			V						NOGO
5	M0	1		R	XXXXXXXX	XXXXXXXX	1.2345	1.2445		1.2347
13	M1			V	Scroll	Scroll	0.	.005		GO
561				R	Scroll	Scroll	0.	.0103		0.002
1534		3		R	Scroll	Scroll	23.450	23.550		23.350 U/S
Scroll					Scroll	Scroll	Scroll	Scroll		Scroll
↓										
Sheet: Section: Zone: Gage:										ContChar:
(Instruction text.....)										
.....										
.....)										
R E S U L T : 2 3 . 4 7 0										
User: John Doe										
Lock	ReadMenu	LotMenu	DispMenu	NewPart						
ReadMenu:										
Gage File										
LotMenu:										
AllParts Components EndInspLot NewLot										
DispMenu:										
QOI Notepad XbarR MovingXbarR PreControl										

### Description:

Data collected by the operator and inspector is entered on this screen. If the lot is serialized, the operator (or inspector) is required to use the NewPart option before data can be recorded. Otherwise, entering the part number is only required if there are non-conformances, in which case a part identification (selecting IdPartsMenu/SinglePart option) must be entered before a new part can be inspected.

Data is entered either by keyboard, or by using the ReadData/Gage option. The latter option causes the characteristic in question to be read in from the gage port and the result displayed on the screen. If the measurement is out of tolerance, a O/S or U/S will appear after the result.

During data entry, the result will be displayed highlighted and blinking on the bottom of the screen so that the result is readable from a distance. The field will show normal color for an in tolerance reading and red for an out-of-tolerance reading.

When an inspector enters data on this screen, she/he cannot enter results where they are also the person who entered results as an operator. If the attempt is made, a message is displayed to the inspector and the result is rejected.

In operation, characteristics can be accessed in any order, even though they are displayed in order. The order of display is determined by character code numerical order, or, alternatively by a display order array if the array is passed through the external file interface.

The gage type listed in the lines under the scrolling area is the gage type matching the gage serial number that was entered on the "Check Gages and Assign Gages to Char Codes" screen. The information for gage type is taken from the data downloaded in the serialized gage information file.

If a serialized gage has not been assigned to the character code, the gage type will read "Gage Not Assigned" and data entered will not be accepted. The user will also receive a message when he/she enters a field that data will not be accepted.

Appraisal codes are interpreted for the two data entry classes (operator and inspector) as listed in the Quality Engineer/Supervisor interface in the "Modify QOI" display.

Fields:

1. Part Number. The part number currently in progress. Obtained from the previous screen. Display only.
2. QOI Rev. The latest QOI revision being used for this operation. Obtained from the QOI database. Display only.

3. Operation Number. The operation number currently in progress. Obtained from the previous screen. Display only.
4. Lot Number. The parent four character lot number and the split number are displayed from the previous screen. Display only.
5. Serial Number. Part serial number or sequence number or, if a non-conformance is detected, unique part identification for this operation. Scroll display only (entry of part identification is by prompt).
6. Char Code. The characteristic code number from the QOI plan. 4 digit integer. Only one character code for each gage serial number required is listed. Scroll display only.
7. Gage Port. 2 digits, integer. The number of the gage port to which a gage is attached and which will be read when requested by the ReadGage option. Scroll display only.
8. R/V. Record or Verify one character. Indicates the type of result to be entered into the Result field. Record indicates that a measurement is required. Verify requires entry of go-nogo results: G or N. Scroll display only.
9. Result. Verify requires entry of N(OGO) for out-of-tolerance, and G(O) for in tolerance. Measurement allows entry of a value, obtained from either the keyboard or, if a port is displayed and the ReadGage option is selected, from a gage. Scroll entry and edit while still in the field. Once the user exercises the LockResults option, all new information is stored in the data base and cannot be edited. The offset is automatically added to the date entered by the user and to display the absolute measurement.
10. Field with no header, immediately after the Result field. A result of O/S for oversize and U/S for undersize measurement will be displayed. Scroll display only.
11. Offset. Entry of a value into this field causes it to be added to the result when the user modifies it and then leaves the offset column. Scroll optional entry only.
12. Min Dim. The minimum dimension from the QOI data base for this part/operation/QOI Rev/char. Scroll display only.
13. Max Dim. The maximum dimension from the QOI data base for this part/operation/QOI Rev/char. Scroll display only.
14. Page. 4 character page location of the characteristic on a drawing. Obtained from the QOI tables. Display only.

15. Operator. 8 character field displaying the operator's result. This field only appears on the inspector's data collection screen.
16. Sheet/Section/Zone. Location of characteristic on drawings. Obtained from the QOI tables. Display only.
17. Gage. 20 character gage type from the Serialized Gage table. Display only.
18. Control Char. 4 integers. A controlling characteristic which is used to substantiate the dependent feature. Obtained from the QOI tables. Display only.
19. Instruction Text. Three lines with 50 characters per line. Free text describing the characteristic and giving instructions on how it should be measured. Obtained from the QOI tables. Display only.
20. R E S U L T. 8 character result display field. Displays the most recent entry into the scrolling result field highlighted and blinking, and uses red color to indicate out of tolerance and normal to indicate within tolerance. Display only.

Menu Options:

1. Lock  
Locks the measurements into the database.
2. ReadMenu  
Brings up a choice of two ways to get measurement data:
  1. Gage - reads a measurement from the gage port.
  2. File - gets a file from the K&T CNC and the LK CMM.
3. LotMenu  
Brings up a menu for part identification so that one of the following can be selected:
  1. Components - allows the user to identify components added to a part. Goes to the Enter Component Information display.
  2. EndInspLot - indicates that this part is going to end an inspection lot. Any last piece release requirements are displayed for this part. Also, any outstanding operator data entry requirements that have not been met are displayed. When the data has been entered for the last piece release, a new inspection lot is automatically started.
  3. New Lot - goes to the Identify New Part Lot screen.



4. AllParts  
Brings up the "All Parts" version of the data collection display.
4. DispMenu  
Brings up a menu of information displays so that the user can choose one of the following:
  1. QOI - shows the QOI plan for the current part/operation/QOI Rev/Char.
  2. Notepad - brings up the notepad screen for the part/lot/operation.
  3. XbarR - plots the x-bar and sigma chart for the current part/operation/char.
  4. MovingXbarR - plots the moving x-bar and r chart for the current part/operation/lot/char.
  5. PreControl - plots the precontrol chart for the current part/lot/operation/char.
5. NewPart - allows the user to inspect a different part.

4.3.8 Data Collect - All Parts

AQAS		Data Collect All Parts		12-AUG-87	
Part Number: 718371		QOI Rev: 01		Operation Number: 00042	
		Lot Number: A111- 11			
Part Characteristic: 0002		Port: 1		R/V: R Offset: 0.0	
Min Dimension: 1.2345		Max Dimension: 1.2445			
Sheet: Section: Zone: Gage:				ContChar:	
(Instruction text.....)					
.....					
.....)					
Serial Number		Result		Operator	
CT104		XXXXXXXX		1.2347	
CT105		XXXXXXXX		1.2348	
CT106		Scroll		1.2448 O/S	
6		Scroll		Scroll	
↓					
V					
R E S U L T : + 1 . 2 4 4 8					
User: John Doe					
Lock ReadMenu LotMenu DispMenu NewChar					
ReadMenu:					
Gage File					
LotMenu:					
AllChars Components NewLot					
DispMenu:					
QOI Notepad XbarR MovingXbarR PreControl					

Description:

Data collected by the operator and inspector is entered on this screen. If the lot is serialized, the serial numbers are displayed. Otherwise, the part sequence number is displayed. A unique part identification for the current operation may be entered if there are non-conformances. If this is the case, a part identification must be entered before a new part can be inspected.

Data is entered either by keyboard, or by using the ReadData/Gage option. The latter option causes the characteristic in question to be read in from the gage port and the result displayed on the screen. If the result is out of tolerance, a O/S or U/S will appear after the result.

During data entry, the result will be displayed highlighted and blinking on the bottom of the screen so that it is readable from a distance. The field will show normal color for an in tolerance reading or red for an out-of-tolerance reading.

When an inspector enters data on this screen, she/he cannot enter results where they are also the person who entered results as an operator. If the attempt is made, a message is displayed to the inspector and the result is rejected.

There is no option for last piece release on this screen because this is the data collection screen all parts. Last piece release always takes place on one part, so the only place where this takes place is on the data collection screen for all characteristics.

In operation, serialized parts can be accessed in any order, even though they are presented in sorted order.

The gage type listed in the display is the gage type matching the gage serial number that was entered on the "Check Gages and Assign Gages to Char Codes" screen. The information for gage type is taken from the data downloaded in the serialized gage information file.

If a serialized gage has not been assigned to the character code, the gage type will read "Gage Not Assigned" and data entered will not be accepted. The user will also receive a message when he/she enters a field that data will not be accepted.

Fields:

1. Part Number. The part number currently in progress. Obtained from the previous screen. Display only.
2. QOI Rev. The latest QOI revision being used for this operation. Obtained from the QOI database. Display only.

3. Operation Number. The operation number currently in progress. Obtained from the previous screen. Display only.
4. Lot Number. The parent four character lot number and the split number are displayed from the previous screen. Display only.
5. Part Characteristic. Verified with the characteristic code number from the QOI plan. 4 digit integer. Obtained from the previous screen (and displayed as a default) or may be typed in. Display and entry.
6. Gage Port. 2 digits, integer. The number of the gage port to which a gage is attached and which will be read when requested by the ReadGage option. Display only.
7. R/V. Record or Verify one character. Indicates the type of result to be entered into the Result field. Record indicates that a measurement is required. Verify requires entry of go-no results: Yes or No. Display only.
8. Offset. Entry of a value into this field is automatically added to the result before storing the information into the data base. Optional entry only when the part characteristic field is entered (this happens when entering the screen or when selecting the NewChar option). Entry only.
9. Min Dimension. The minimum dimension from the QOI data base for this characteristic. Display only.
10. Max Dimension. The maximum dimension from the QOI data base for this characteristic. Display only.
11. Sheet/Section/Zone. Location of characteristic on drawings. Obtained from the QOI tables. Display only.
12. Gage. 20 character gage type from the Serialized Gage table. Display only.
13. Control Char. 4 integers. A controlling characteristic which is used to substantiate the dependent feature. Obtained from the QOI tables. Display only.
14. Instruction Text. Three lines with 50 characters per line. Free text describing the characteristic and giving instructions on how it should be measured. Obtained from the QOI tables. Display only.
15. Serial Number. Part serial number or sequence number or, if a non-conformance is detected, unique part identification for this operation. Scroll display only (entry of part identification is by prompt).

16. Result. Verify requires entry of N(OGO) for out-of-tolerance, and G(0) for in tolerance. Measurement allows entry of a value, obtained from either the keyboard or, if a port is displayed and the ReadGage option is selected, from a gage. Scroll entry and edit while still in the field. Once the user leaves the field, it is stored in the data base and cannot be again edited.
17. Field with no header, immediately after the Result field. A result of O/S for oversize and U/S for undersize measurement will be displayed. Scroll display only.
18. Operator. 8 character field displaying the operator's result. This field only appears on the inspector's data collection screen. Display only.
19. R E S U L T. 8 character result display field. Displays the most recent entry into the scrolling result field highlighted and blinking and uses red color to indicate out of tolerance and normal to indicate within tolerance. Display only.

Menu Options:

1. Lock  
Causes all entered data to be locked into the database. Until this is done, data may be edited by this user, but may not be viewed by other users.
2. ReadMenu  
Brings up a choice of two ways to get measurement data:
  1. Gage - reads a measurement from the gage port.
  2. File - gets a file from the K&T CNC and the LK CMM.
3. LotMenu
  1. AllChars - Brings up the "All Characteristics" version of the data collection display.
  2. Components - allows the user to identify components added to a part. Goes to the Enter Component Information display.
  3. NewLot - goes to the Identify New Part Lot screen.
4. DispMenu  
Brings up a menu of information displays so that the user can choose one of the following:
  1. QOI - shows the QOI plan for the current lot.

2. Notepad - brings up the notepad screen.
  3. XbarR - plots the x-bar and sigma chart for the current part/operation
  4. MovingXbarR - plots the moving x-bar and r chart for the current part/operation/lot.
  5. PreControl - plots the precontrol chart for the current part/lot/operation.
- 
5. NewChar - allows the user to inspect a different characteristic.

#### 4.3.9 Notepad

AQAS	Notepad	12-AUG-87
Part Number: 12345678901234567890		
Lot Number: A234- 12		
Operation Number: 01234		
12 July, 1987 21:34:34.05 Harold Q. Employee Split off one part for the MetLab. Never got there.		
Scroll		
Scroll		
Scroll		
Scroll		
Scroll		
Scroll		
Scroll		
Scroll		
Scroll		
User: John Doe		
EnterNotes      NextOp		
EnterNotes Menu:		
DisplayAll      StoreNotes		

#### Description:

Information pertaining to a part, lot, and operation is displayed on this screen. New notepad information can also be entered from this screen. When the user enters, the screen is in the display mode and the default part/operation/lot are used to display existing comments. In this mode, information is displayed in chronological order listing the individual responsible, date and time of the note. The user can scroll through the list of notes.

At any time, the user may change the part, lot or operation fields to see the notes for a different part lot or operation.

By selecting the EnterNotes option, a second, data entry mode, is toggled where only the comments of the current user are displayed and are available to be edited or appended.

Comments are stored in the data base from the enter mode by selecting the StoreNotes option. If the user tries to leave the notepad (with the next or previous screen option), he/she is told that new comments will not be stored and asked to confirm their intent to leave.

NOTE: At no time can a user change the comments belonging to different person.

Fields:

1. Part Number. 20 character part number field which is loaded with the default part number from the previous screen. Display/Entry.
2. Lot Number. The parent four character lot number and the split number are displayed from the previous screen. Display/Entry.
3. Operation Number. One character and four digit operation number which is loaded with the default operation number from the previous screen. Display/Entry.
4. Notepad scroll area. This is an 80 column by 12 line display or entry area where the user can scroll through the comments entered. If the entry mode is in effect, the current user's comments only are displayed and may be changed or appended to. If the display mode is in effect, all comments about this part/lot/operation are displayed for the user to scroll through, but no data entry is allowed.

Menu Options:

1. EnterNotes or DisplayAll  
Toggles between the display comments and enter comments modes.
2. StoreNotes  
Stores comments that have been entered in entry mode. Must be selected for changes to be loaded into the data base.
3. NextOp Goes to the next operation (in increasing numerical order) that has notepad comments. Can be used repeatedly to move through many operations until the last operation for which there are comments is found. NOTE: changing the operation field only affects the display and entry of comments and has no effect on the default part/lot/operation passed into the screen or used by following screens.



#### 4.3.10 Enter Component Information

AQAS		Enter Component Information		12-AUG-87	
Part Number: 718371		QOI Rev: 01		Operation Number: 00042	
		Lot Number: A111- 11			
		Assembly Part Serial Number: CT103			
Part Number		Component Identification		Quantity	
XXXXXXXXXXXXXXXXXX		XXXXXXXXXX		XXXX	
Scroll		Scroll			
↓		↓			
V		V			
User: John Doe					
StoreComponents Serialized					

#### Description:

Component serial numbers or heat codes for a given individual assembly (finished) part serial number are entered on this screen. As each component serial number and component part number are entered, they are checked against existing data. If the component part number/serial number exists, the user is informed and is asked to reenter the data.

Component part numbers and heat codes are not checked for uniqueness and can be entered multiple times. To speed data entry, the operator can use the "Select and Insert" capability on the part number field.

When this screen is first initialized for a new inspection lot, the component part numbers will have to be entered. For the rest of the inspection lot, the previously entered component part numbers will be preloaded into the part number fields as defaults (they can be changed if required).

The screen shown is for components identified by heat code. There is also a version for components identified by serial number. (not shown)

Fields:

1. Part Number. The part number currently in progress. Obtained from the previous screen. Display only.
2. QOI Rev. The latest QOI revision being used for this operation. Obtained from the QOI database. Display only.
3. Operation Number. The operation number currently in progress. Obtained from the previous screen. Display only.
4. Lot Number. The parent four character lot number and the split number are displayed from the previous screen. Display only.
5. Assembly Serial Number. Part serial number or sequence number. Obtained from the previous screen. Display only.
6. Component Part Number. 20 characters. The component part number is entered here for the first call in an inspection lot. Thereafter, the previously known component part numbers will be preloaded into the fields. Scroll entry only.
7. Component Identification. Entry of the component serial number or heat code is made here. This is checked against existing component part/serial numbers if a serial number is entered, and not checked if a heat code is entered. Scroll entry only.
8. Quantity. Entry of quantities for HEAT CODE INFORMATION ONLY. This field is set to one and cannot be changed for serial numbers. For heat codes, the user can scroll through the list of heat codes and select the menu option to "AddQuantity."

Menu Options:

1. StoreComponents  
Stores component serial information that is on the display. This option is only valid if a serial number is entered for each component part number on the display. Individual serial numbers have been previously checked at the time of entry.
2. Serialized  
Brings up the screen for serialized components.

#### 4.3.11 QOI Display

AQAS	QOI Display	12-AUG-87
Part Number: 718371	Part Name: Rotor, Ax Cprsr	
Operation: 0042	Work Center: 308	
B/P Rev: AG	QOI Rev: 02	
Char Code: 0019	Control Char:	
Appraisal Code:	Verify/Record:	
Sheet:	Section:	Zone:
QOS Page:	Dimension Type:	
Maximum:	Minimum:	
Gage Type:		
Gage Type:		
Gage Type:		
Gage Type:		
(Instruction text..... ..... ..... ..... .....)		
User: John Doe		
NextChar SelectChar		

#### Description:

QOI information for a part, operation, characteristic is displayed on this screen. The display scrolls to display all instruction text found on the QOI.

#### Fields:

1. Part Number. 20 characters. The part number currently in progress. Obtained from the previous screen. Display only.
2. Part Name. 20 characters. The first twenty characters of the part description in the database.

3. B/P Rev. 2 characters. Blue print revision obtained from the QOI information. Display only.
4. QOI Rev. The latest QOI revision being used for this operation. Obtained from the QOI database. Display only.
5. Operation Number. The operation number currently in progress. Obtained from the previous screen. Display only.
6. Work Center 6 characters. Work Center number obtained from the QOI data in the data base. Display only.
7. Char Code. 4 integers. The characteristic code number obtained from the QOI plan. Display only.
8. Control Char. 4 integers. A controlling characteristic which is used to substantiate the dependent feature. Display only.
9. Appraisal Code. 2 characters. The appraisal code obtained from the QOI data. Display only.
10. Verify/Record. 1 character. Indicates whether this is a verify (Y/N) or a record (input reading) characteristic. Display only.
11. Sheet/Section/Zone. Location of characteristic on drawings. Display only.
12. QOS Page Number. 3 digits. Page number of the QOS where the character code is to be found. Display only.
13. Dimension Type. 4 characters. Indicates the kind of measurement to be taken. (Inner Diameter, etc.) Display only.
14. Maximum. 8 digit real number. Maximum value of tolerance range. Display only.
15. Minimum. 8 digit real number. Minimum value of tolerance range. Display only.
16. Gage Type. 20 characters. Obtained from the QOI information. Display only.
17. Instruction Text. 50 characters per line. Free text describing the characteristic and giving instructions on how it should be measured. Scroll display only.

Menu Options:

1. NextChar  
This option changes the character code displayed to the next higher character code for the current part, operation, QOI revision.
2. SelectChar  
When this option is selected, the user is prompted for a character code of interest. The screen will show QOI information for the selected character code.

4.3.12 Final Inspection Checklist

AQAS		Final Inspection Checklist		28-Feb-88	
Part Number: 714830		Lot Number: A360-001			
QOI Revision: 01		Operation Number: 0340			
P/F	Inspector	Review			
P	1750	Review Lot Contents			
P	1750	Review Lot Documentation			
		Review Operation Summary			
		Review Notes for this Operation			
F	11111	Perform Final Part Inspection on Lot			
User: John Doe					
Review(F5) Pass(F6) Fail(F7) Notepad(F8)					

Description:

The Final Inspection Checklist presents a list of items for the inspector to review before the lot completes final inspection. Only inspectors can perform a final inspection.

From the Enter Inspection Information screen, an inspector selects "InspectMenu" to perform an inspection operation. Normally this option brings up a sub-menu which allows the user to set-up gages, or go directly to one of the data entry screens. When the operation is a final inspection operation, the user enters the Final Inspection Checklist screen instead. The last QOI operation for a part number (or part lot) is assumed to be final inspection. The same rules apply for starting final inspection as any other operation.

Once in this screen, an inspector reviews information about the lot. This is done by examining various screens which show summary information about the current lot or lot history. By selecting an item and choosing "Review" from the menu, the user can look at these screens. In the case of the Lot Documentation, the user should review the physical documentation for the lot.

After reviewing the information, the inspector can pass or fail the check. Upon doing so, he/she is prompted for his/her password. The result and the inspector's badge number are recorded and displayed. If the inspector Fails a check, he/she can record detailed information in the notepad explaining why the lot did not pass, and any corrective measures suggested.

After all of the individual checks have passed, the inspector can complete the operation from the Enter Inspection Information screen by selecting OpDone. At this time, an audit check is run if any characteristics require it. In addition to the normal checks performed at the end of an operation, all of the final inspection reviews must be passed by an inspector.

If there are no notes for an operation, that review is automatically passed.

The status (pass/fail) of a review may be changed at any time until the final inspection operation is completed.

Fields:

1. Part Number: The part number of the lot undergoing final inspection. Display only.
2. Lot Number: The lot number of the lot undergoing final inspection. Display-only.
3. QOI Revision: The latest QOI revision being used for this screen. Display Only.
4. Operation Number: The final inspection operation number. Display only.
5. P/F: Pass/Fail flag for each item in the checklist. Display only. (Modified using the menu items).

6. Inspector: The badge number of the inspector who completed the review. Display only.

Menu Options:

1. Review

Selecting this choice will send the user to another screen to review information for the lot. The screen he/she goes to is determined by which item in the list the cursor rests on.

SELECTION	SCREEN
Review Lot Contents	Lot Contents
Review Lot Documentation	-----
Perform Final Part Inspection on Lot	Data Collect Branch
Review Operation Summary	Operation Summary
Review Notes for this Operation	Notepad

2. Pass

Selecting pass indicates that the lot has passed this review. The inspector must input his/her password, and his/her badge number is recorded and displayed.

3. Fail

Selecting fail indicates that the lot has failed this review. The inspector must input his/her password, and his/her badge number is recorded and displayed.

4. Notepad

This option brings up the Notepad screen for this part/lot/operation.

#### 4.4 SUPERVISOR/ENGINEER INTERFACE

This interface is used by quality supervisors and engineers to review, analyze, and act on part measurement, non-conformance, and process control data. Unlike the operator/inspector interface, which leads the user step by step through the standard inspection sequence, the supervisor/engineer interface gives the user flexibility in the order of accessing displays at the cost of small increase in the number of keystrokes.

The tree has six main branches:

1. View/Modify Operations on Lots

This branch is used to list, view, and modify how a particular lot has been or will be processed through a particular operation.

2. View/Modify Current Lot Status

This branch is used to view the contents of active lots, to split those lots, to resolve any non-conformances within those lots, and to change serial numbers and/or heat codes that were typed in incorrectly. One method of resolving a non-conformance is to split parts off for MRB review.

3. Remove Parts From MRB Status

This branch is used to list and resolve non-conformances on parts that have been split off from production lots for MRB study.

4. Analyze Process Control

This branch is used to perform process control and analysis on part-operations.

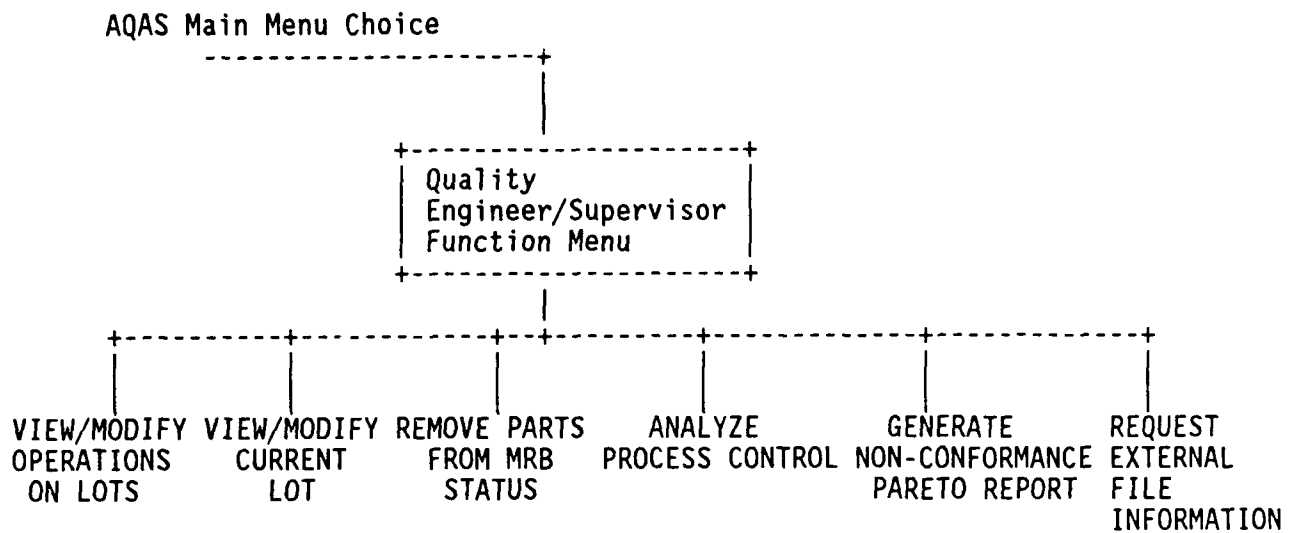
5. Generate Non-Conformance Pareto Reports

This branch is used to view pareto reports on the distribution of non-conformances to help determine where process improvement effort should be concentrated.

6. Request External File Information to be Read into AQAS

This branch is made up of one screen that is used to read in an update to QOI, Part-Lot, and Gage Calibration data.





Main Menu for QE/Supervisor Interface

#### 4.4.1 Quality Engineer/Supervisor Menu

AQAS	Quality Engineer / Supervisor Function Menu	12-AUG-87
1. View/Modify Operations on Lots		
2. View/Modify Current Lots		
3. Remove Parts from MRB Status		
4. Analyze Process Control		
5. Generate Non-Conformance Pareto Reports		
6. Request External File Information be Read into AQAS		
Enter Selection: X		
User: John Doe		

This top-level menu for the Quality Engineer/Supervisor Interface shows the choice of five main branches to take.

The following pages show each of these branches in detail.

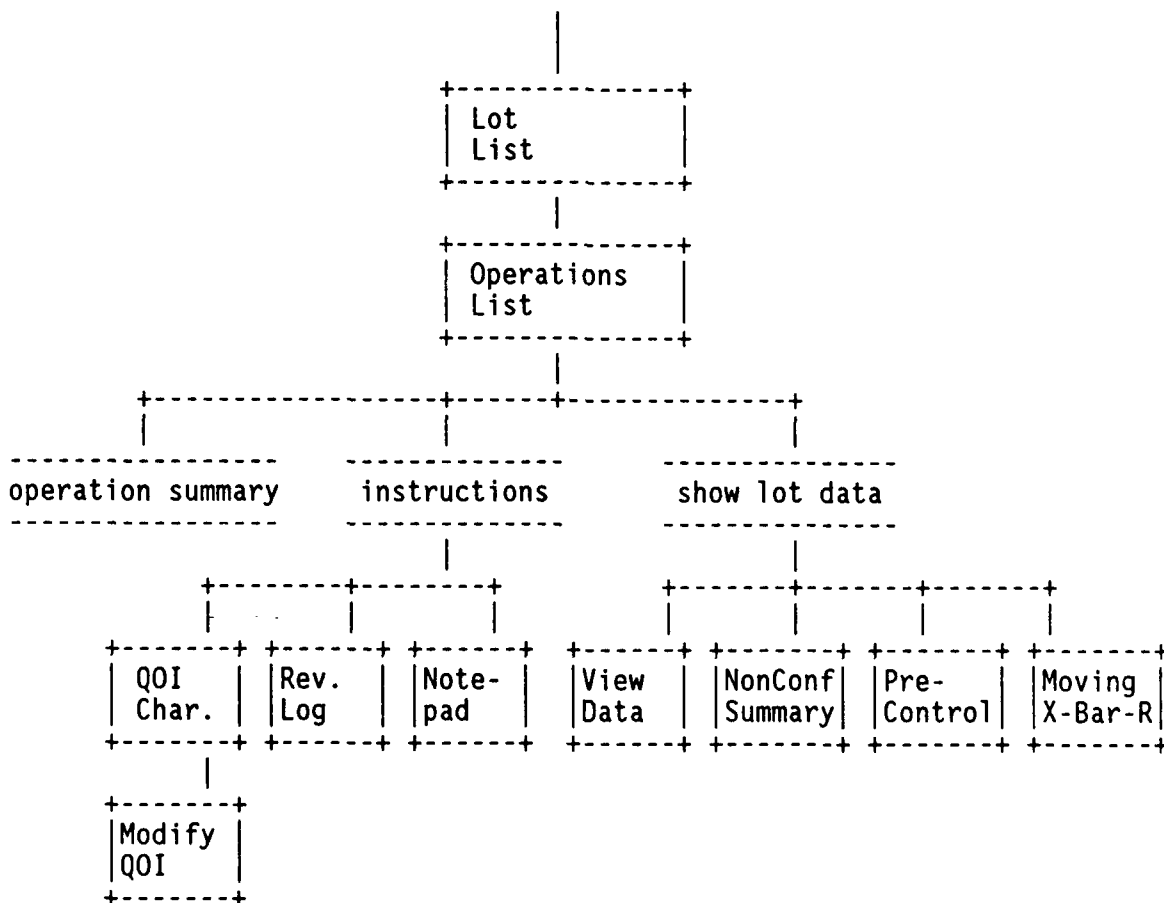
#### 4.4.2 View/Modify Operations On Lots Branch

This branch is used to view and modify information about particular operations that have been or will be performed on a particular lot.

A supervisor may use this branch to look at and change instructions for a future operation. For instance, he can add a note explaining a special procedure, or he may allow the use of an alternate gage.

He may also use this branch to look at the instructions used or the readings taken for a lot in the past.

This branch is targeted towards studying a particular lot. If the supervisor is interested in the overall performance of a process, he should go to the Analyze Process Control Branch.



VIEW/MODIFY OPERATIONS ON LOTS BRANCH

#### 4.4.2.1 Lots List

AQAS	Lots List		12-AUG-87
	Part Number	Lot Number	
	718371	A111- 11	
	718375	A001- 00	
	.	.	
	.	.	
	.	.	
	.	.	
	.	.	
	.	.	
	.	.	
	.	.	
	.	.	
	.	.	
User: John Doe			
list-ops			

#### Description:

This display shows the lots that AQAS knows about.

The user moves the cursor to a specific lot with the up and down arrows or with the find key. He then selects "list-ops" to see a list of operations to view data on.

#### Fields:

1. Part Number  
This field gives the part number for the lot-operation listed.
2. Lot Number  
Shows the lot number for the lot-operation listed. Revision used for the lot-operation listed.

Menu Options:

1. List-Ops  
Brings up the operations list display.

4.4.2.2 Operations List

AQAS		Lot-Operations List		12-AUG-87
Part Number: 718371		Lot Number: A111- 11		
	Operation		QOI Revision	
	00042		A01	
	00042		A02	
	.		.	
	.		.	
	.		.	
	00050		A02	
	.		.	
	.		.	
	.		.	
User: John Doe				
instructions	lot-data	future operation	operation summary	
QOIchar	RevisionLog	NotePad	(instructions)	
readings	pre-control	moving-x-bar-r	summary	(lot-data)

Description:

This display shows the operations for a previously selected lot that AQAS knows about. Note that all operations for the lot are listed to allow the user to select information about a past or future operation on a lot. To select a future operation, the user must use the menu choice "future operation". This allows him to specify an OSO version for that future operation.

The user moves the cursor to a specific operation with the up and down arrows or with the find key. He then selects "instructions" or "lot-data" to see more information.

Fields:

1. Part Number  
This field gives the part number for the lot-operation listed.
2. Lot Number  
Shows the lot number for the lot-operation listed.
3. Operation  
Shows the operation for the lot-operation listed.
4. QOI Revision  
Shows the QOI Revision used for the lot-operation listed.

Menu Options:

1. Instructions  
bring up the following choices:
  - QOIchar
  - RevisionLog
  - NotePad
2. Lot-Data  
brings up the following choices:
  - Readings
  - Summary
  - Pre-Control
  - Moving-X-Bar-R
3. Future operation  
Prompts the user for a specific operation and OSO version. If valid, that operation is added to the list of operations that AQAS has knowledge of.

4.4.2.3 Notepad Screen

See Operator/Inspector Interface.

4.4.2.4 QOI Display

See Operator/Inspector Interface.

#### 4.4.2.5 Operation Summary

AQAS		Operation Summary				28-Feb-88	
Part Number: 714830				Lot Number: A360-001			
QOI OPERATIONS				ACTUAL OPERATIONS COMPLETED			
QOI Oper	QOI Rev	Oper	Lot	Start	End		
0010	01	0010	A360	12-DEC-1988 10:00	12-DEC-1988 12:00		
0020	00	----	-----	-----	-----		
0025	02	0025	A360	13-DEC-1988 13:12	13-DEC-1988 14:00		
0030	01	0030	A360-001	13-DEC-1988 15:11	14-DEC-1988 09:02		
0050	02	0050	A360-001	14-DEC-1988 11:11	14-DEC-1988 13:00		
0100	03	0100	A360-001	15-DEC-1988 10:12	16-DEC-1988 12:00		
User: John Doe							

#### Description:

The Final Inspection Operation Summary Screen displays all the operations on the QOI for a particular part/lot and the history of all operations performed on the lot.

At final inspection, the inspector can review this screen to determine whether or not important QOI operations were skipped. If a QOI operation exists which was not performed, the deviation from the QOI is displayed to the user. When the inspector returns to the final inspection checklist, he can fail the review, and note the reason.

The screen also shows the history of the lot numbers to which the parts belonged.

Fields:

1. Part Number: The part number of the lot undergoing final inspection.  
Display only.
2. Lot Number: The lot number of the lot undergoing final inspection.  
Display only.
3. QOI Oper: The operation to be performed from the QOI. Display only
4. QOI Revision: The QOI revision to be used for each operation.  
Display only.
5. Oper Number: The operation number which was actually performed.  
Display only.
6. Lot: The lot number to which the parts belonged when the operation  
was performed. This changes when parts are split off from a parent  
lot. Display only.
7. Start: Operation start date and time. Display only.
8. End: Operation end date and time. Display only.



#### 4.4.2.6 Modify QOI Display

AQAS	QOI Display	12-AUG-87
Part Number: 718371	Part Name: Rotor, Ax Cprsr	
Operation: 0042	Work Center: 308	
B/P Rev: AG	QOI Rev: 02	
Char Code: 0019	Control Char:	
Appraisal Code:	Verify/Record:	
Sheet:	Section:	Zone:
QOS Page:	Dimension Type:	
Maximum:	Minimum:	
Gage Type:		
Gage Type:		
Gage Type:		
Gage Type:		
(Instruction text.....)		
.....		
.....		
.....		
.....)		
User: John Doe		
NextChar StoreChange		

#### Description:

QOI information for a part, operation, characteristic that can be changed is highlighted on this screen.

Appraisal codes are defined by a letter followed by either one or two digits.

#### Fields:

1. Part Number. 20 characters. The part number currently in progress. Obtained from the previous screen. Display only.

2. Lot Number. 8 characters. Display only.
3. QOI Rev. The latest QOI revision being used for this operation. Obtained from the QOI database. Display only.
4. Operation Number. The operation number currently in progress. Obtained from the previous screen. Display only.
5. Char Code. 4 integers. The characteristic code number obtained from the QOI plan. Scroll display only.
6. Appraisal Code. 3 characters. The appraisal code obtained from the QOI data. Display and enter.
7. Gage Type: 20 characters. Obtained from the gage data. Display and enter.

Menu Options:

1. NextChar  
Displays the information for the next characteristic for the operation.
2. StoreChange  
Stores changes to the QOI in the database. These changes apply to this lot only. The user will be prompted for a password to authorize the change.

4.4.2.7 QOI Revision Log

AQAS	QOI Revision Log	12-AUG-87
Part Number: 718371	Lot Number: 111- 11	
Operation: 0042	QOI Revision: 01	
Valid OSO Revisions		
AE01		
AE02		
AF03		
XXXX		
User: John Doe		
AddOSO StoreChange NewQOI		

Description:

This display shows the list of OSO revisions valid for this QOI revision.

Fields:

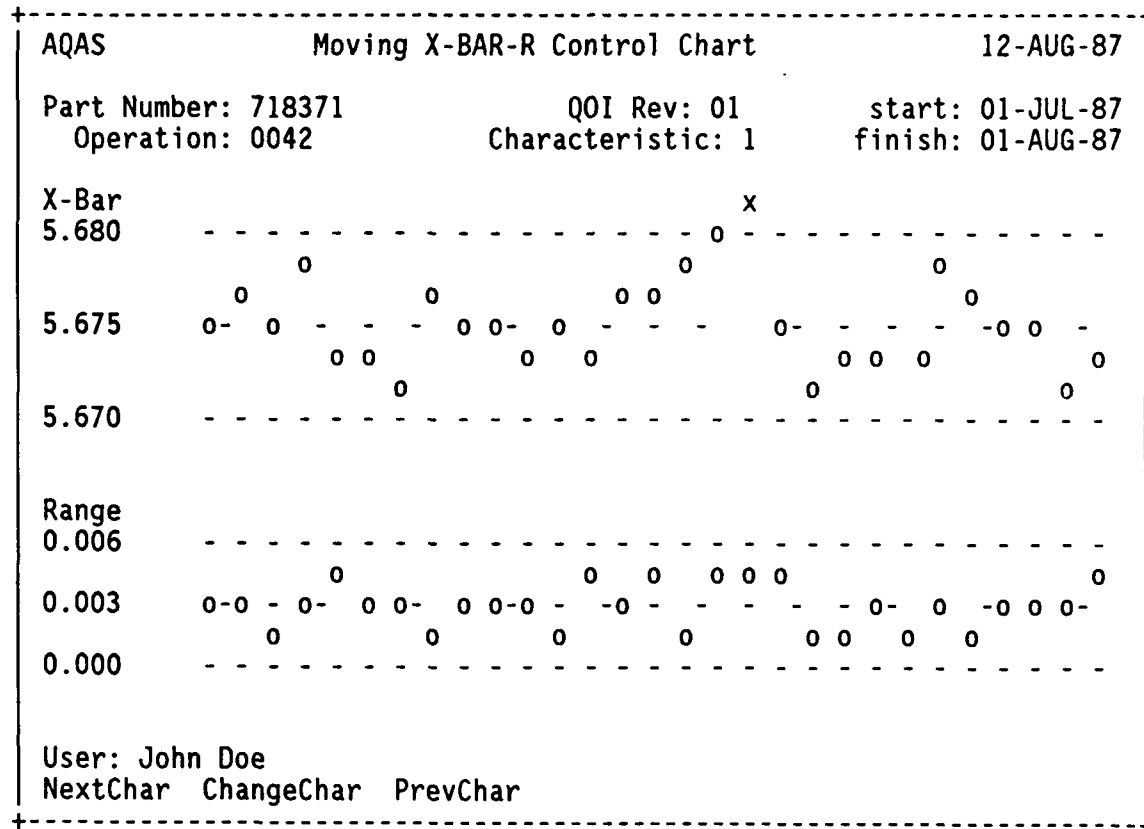
1. Part Number. 20 characters. The part number currently in progress. Obtained from the previous screen. Display only.
2. Lot Number. 8 characters. Display only.
3. QOI Rev. 2 characters. The latest QOI revision being used for this operation. Obtained from the QOI database. Display only.
4. Operation Number. 7 characters. The operation number currently in progress. Obtained from the previous screen. Display only.

5. Valid OSO Revision. 4 characters. A list of OSO revisions which can be used with the QOI shown. Display only. May be extended by using the AddChar menu option.

Menu Options:

1. AddOSO  
Prompts the user for a new OSO revision number to approve for use with this QOI revision.
2. StoreChange  
Stores all additions to the QOI revision log. These changes apply to the current inspection lot only. The user will be prompted for a password to authorize the change.
3. NewQOI  
Prompts the user for a new QOI revision. Shows the OSOs valid for that QOI revision. Note that this does NOT change the current QOI for the lot.

#### 4.4.2.8 Moving X-BAR-R Control Chart



#### Description:

This is a Moving X-BAR-R chart. It differs from a standard X-BAR-R chart in the composition of the sample groups. In a moving X-Bar-R chart, there are two samples in each group, and the sample groups overlap.

Depending on where in the user interface the user has selected this screen, he may see a special screen for selecting a specific characteristic to study. In that case, he enters a characteristic to study and choose "display" or "print" from the menu line.

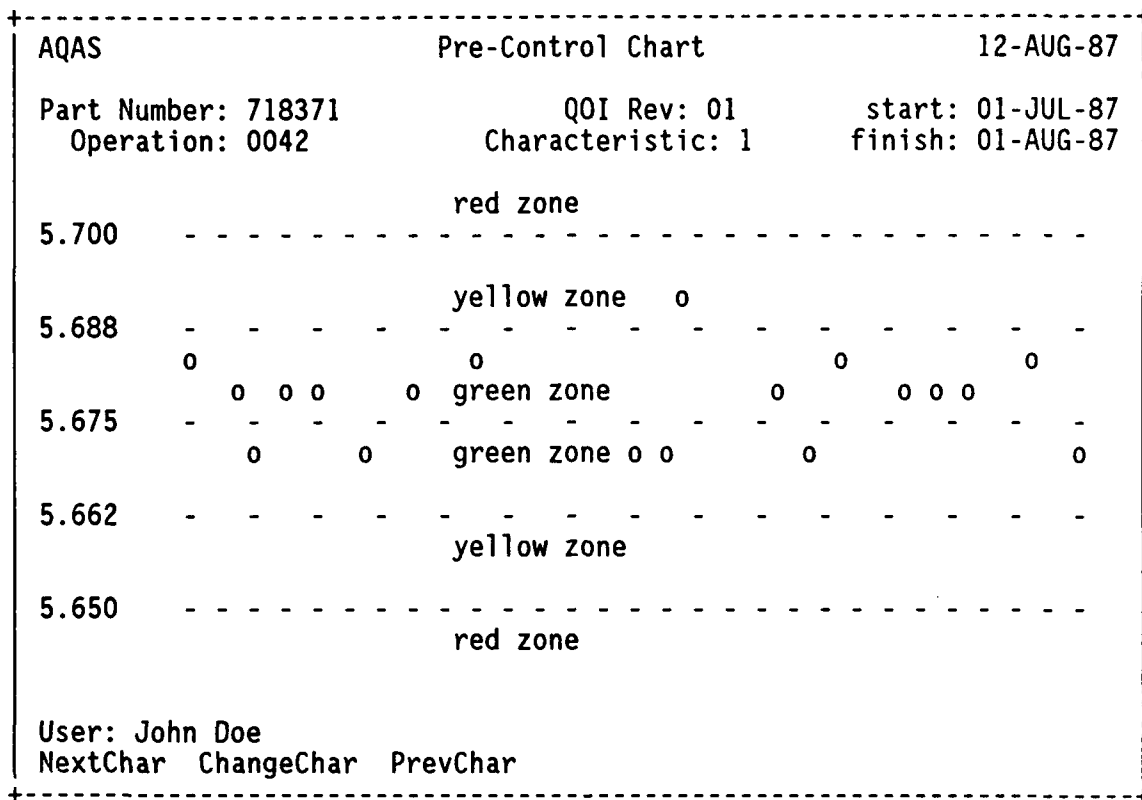
Fields:

1. Part Number. 20 characters. The part number of the operation being studied.
2. QOI Rev. 2 characters. The QOI revision used for the operation. Obtained from the QOI database. Display only.
3. Operation Number. 7 characters. The operation number being studied.
4. Characteristic. 4 characters. The characteristic being studied.
5. Start. Date. The beginning date for the time period being studied.
6. Finish. Date. The ending date for the time period being studied.
7. Chart Region. This area is a graphic representation of a control chart. Out-of-control points are shown in a contrasting color and/or shape. Displays last 40 data points.

Menu Options:

1. NextChar  
Shows the control chart for the next characteristic.
2. ChangeChar  
Prompts the user for a new characteristic number.
3. PrevChar  
Shows the control chart for the next lower characteristic number.

#### 4.4.2.9 Pre-Control Chart



#### Description:

This is a "Pre-Control" chart. It shows the distribution of individual measurements within the current inspection lot. Points shown in green are within 50% of tolerance from the nominal value. Points in yellow are still within tolerance, but outside that central zone. Points in red are out of tolerance.

If the lower tolerance for a characteristic is "0.000", this chart will be presented in a "one-sided" format. That is, the green zone will extend from 0.000 to 50% of the way to the tolerance. The yellow zone will extend from there to the tolerance. The red zone will cover points outside the tolerance.

Depending on where in the user interface the user has selected this screen, he may see a special screen for selecting a specific characteristic to study. In that case, he enters a characteristic to study and choose "display" or "print" from the menu line.

Fields:

1. Part Number. 20 characters. The part number of the operation being studied.
2. QOI Rev. 2 characters. The QOI revision used for the operation. Obtained from the QOI database. Display only.
3. Operation Number. 7 characters. The operation number being studied.
4. Characteristic. 4 characters. The characteristic being studied.
5. Start. Date. The beginning date for the time period being studied.
6. Finish. Date. The ending date for the time period being studied.
7. Chart Region. This area is a graphic representation of a control chart. Out-of-control points are shown in a contrasting color and/or shape. Displays last 40 data points for specified period.

Menu Options:

1. NextChar  
Shows the control chart for the next characteristic.
2. ChangeChar  
Prompts the user for a new characteristic number.
3. PrevChar  
Shows the control chart for the next lower characteristic number.



4.4.2.10 Non-Conformance Summary / Pareto Characteristic Report

AQAS		Non-Conformance Summary		12-AUG-87	
Part Number: 718371		QOI Rev: 01			
Operation Number: 00042		Lot Number: A111- 11			
Non-Conf Chars: 7		Non-Conf Parts: 6			
Parts Resolved: 2		Parts Split-Off: 2			
Division (characteristic)		Number of Non-Conformances			
		0		5	
.....		00000000000000000000000000000000		5	
		000000000000000000000000		3	
		0000000000000000		2	
		0000000		1	
		0000000		1	
		0000000		1	
		0000000		1	
		0000000		1	
User: John Doe					

Description:

This is a summary of the non-conformances for this production lot. It includes a Pareto report of non-conformances by characteristic.

Fields:

1. Part Number. 20 characters. The part number of the operation being studied.
2. QOI Rev. 2 characters. The QOI revision used for the operation. Obtained from the QOI database. Display only.
3. Operation Number. 7 characters. The operation number being studied.

4. Non-Conf Chars - the number of characteristics with out-of-tolerances for one or more parts.
5. Non-Conf Parts - the number of parts with out-of-tolerances for one or more characteristics.
6. Parts Resolved - the number of parts with resolved non-conformances.
7. Parts Split-Off - the number of parts in the MRB lot for this operation. Note that as those parts get assigned to new lots, this number will decrease.
8. Division(characteristic) - the categories into which the non-conformances are broken down. For this display, the divisions are characteristic codes.
9. Number of Non-Conformances - the number of non-conformances for the given characteristic.

Menu Options:

1. None

#### 4.4.2.11 Data Review - All Parts

AQAS		Data Review All Parts		12-AUG-87	
Part Number: 718371		QOI Rev: 01			
Lot Number: A111- 11		Operation: 00042			
Part Characteristic: XXXX		Port: 1 R/V: R			
Min Dimension: 1.2345		Max Dimension: 1.2445			
Gage Type:					
Serial Number	Inspector	Operator	Rework		
CT104	1.2348	1.2347			
CT105	scroll	1.2348			
CT106	Scroll	1.2448 O/S			
4	Scroll	Scroll			
5	Scroll	Scroll			
6	Scroll	Scroll			
↓					
User: John Doe					
AcquireData OperDelete InspDelete					

#### Description:

Data collected by the operator, inspector and from rework are shown on this screen. If the lot is serialized, the serial numbers are displayed. Otherwise, the part sequence number or temporary number is displayed.

In operation, serialized parts can be accessed in any order, even though they are presented in sorted order.

#### Fields:

1. Part Number. The part number currently in progress. Obtained from the previous screen. Display only.

2. QOI Rev. The latest QOI revision being used for this operation. Obtained from the QOI database. Display only.
3. Operation Number. The operation number currently in progress. Obtained from the previous screen. Display only.
4. Lot Number. The parent four character lot number and the split number are displayed from the previous screen. Display only.
5. Part Characteristic. Verified with the characteristic code number from the QOI plan. 4 digit integer. Obtained from the previous screen (and displayed as a default) or may be typed in. Display and entry.
6. Gage Port. 2 digits, integer. The number of the gage port to which a gage was used to get this reading. Display only.
7. R/V. Record or Verify one character. Indicates the type of result in the Result field. Record indicates that a measurement was required. Verify required entry of go-no results: Yes or No. Display only.
8. Min Dimension. The minimum dimension from the QOI data base for this characteristic. Display only.
9. Max Dimension. The maximum dimension from the QOI data base for this characteristic. Display only.
10. Serial Number. Part serial number or sequence number or, if a non-conformance is detected, unique part identification for this operation. Scroll display only.
11. Field with no header, immediately after the two results fields. Shows oversize (O/S) or Undersize (U/S). Scroll display only.
12. Inspector. 8 character field displaying the inspector's result. Display only.
13. Operator. 8 character field displaying the operator's result. This field only appears on the inspector's data collection screen. Display only.

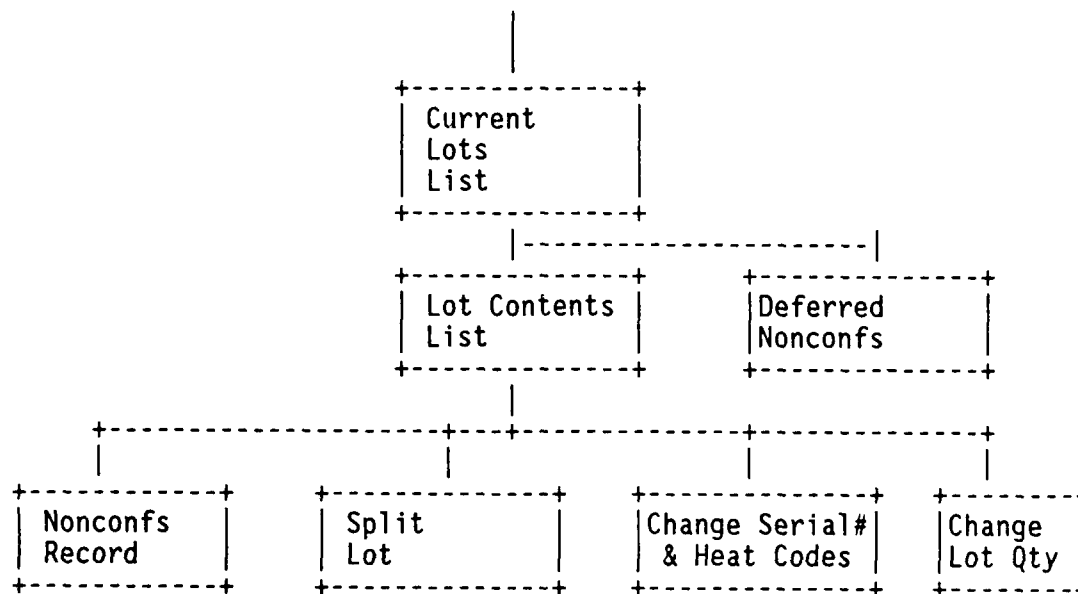
Menu Options:

1. AcquireData  
Calls for the data for the characteristic shown.

2. OperDelete  
Removes all measurements taken so that parts can be screened. Prompts the user for a password to authorize the screening of measurements.
3. InspDelete  
Removes all measurements taken by inspectors so that audit can be redone. Prompts the user for a password to authorize the screening of measurements.

#### 4.4.3 View/Modify Current Lot Branch

This branch is used for taking concrete action on a lot. As such, it is only concerned with where the lot is now, not what operations it may have been through in the past. Since taking measurement readings is the job of inspectors and operators, this branch deals only with splitting lots, resolving non-conformances, and changing serial numbers and/or heat codes which were typed in incorrectly.



VIEW/MODIFY CURRENT LOT BRANCH

AQAS		Current Lots List		12-AUG-87
	Part Number	Operation	Lot Number	QOI Revision
	718371	00055	A111- 11	A01
	718375	00001	A001- 00	B00
	.	.	.	.
	.	.	.	.
	.	.	.	.
	.	.	.	.
	.	.	.	.
	.	.	.	.
	.	.	.	.
	.	.	.	.
	.	.	.	.
	.	.	.	.
	.	.	.	.
	.	.	.	.
User: John Doe contents				

This display shows the lots that AQAS knows about. Note that the last known operation for a lot is shown.

**Fields:**

1. Part Number  
This field gives the part number for the lot-operation listed.
2. Lot Number  
Shows the lot number for the lot-operation listed.

3. Operation  
Shows the operation for the lot-operation listed.
4. QOI Revision  
Shows the QOI Revision used for the lot-operation listed.

Menu Options:

1. Contents  
Bring up the lot contents display.



#### 4.4.3.2 Lot Contents List

AQAS		Lot Contents List		12-AUG-87
Part Number: 718371		QOI Rev: 01		
Operation Number: 00042		Lot Number: A111- 11		
Lot Quantity: 4				
Part ID	Temp ID	Count of Non-Confs	Status	
CT105				
CT106		2	MRB-split	
CT107		1	questionable	
CT108				
User: John Doe				
detail split changeS/N adjustQty				

#### Description:

This display shows the current contents of the lot.

#### Fields:

1. Part Number  
This field gives the part number for the lot-operation listed.
2. Lot Number  
Shows the lot number for the lot-operation listed.
3. Operation  
Shows the operation for the lot-operation listed.

4. QOI Revision  
Shows the QOI Revision used for the lot-operation listed.
5. Lot Quantity  
Shows the number of parts in the lot.
6. Part ID  
Shows the serial number or temporary number for the part, if any.
7. Temp ID  
Shows the temporary number (if any) assigned to this part by AQAS. The temporary number is unique within the part lot, and is carried over from one operation to the next.
8. Non-Conf Count  
Shows the number of out-of-tolerances against that one part.
9. Status  
Shows the current status of the non-conformance on that part. Possible values are GOOD, QUESTIONABLE, NONCONF, MRB-SPLIT.

Menu Options:

1. Detail  
Brings up the Non-Conformance Record for the selected part.
2. Split  
Brings up the split screen for the lot.
3. ChangeS/N  
Brings up the screen for changing serial numbers and heat codes.
4. AdjustQty  
Brings up the screen for collecting lot quantities.

#### 4.4.3.3 Deferred Nonconformance Screen

AQAS		Deferred Nonconformance Screen		28-Feb-88
Part Number: 714830		Lot Number: A360-001		
Operation: 0150		QOI Rev: 01		
Part ID	Characteristic	Operation Detected	Operation Deferred	
AB1001	0018	0050	0170	
AB1001	0019	0050	0170	
AB1002	0026	0100	0260	

User: John Doe  
(F6)QOIDisp (F7)Notes

#### Description:

This screen allows a user to view all the nonconformances for an active lot which have been deferred to future operations. Since these nonconformances have been deferred, they are not active at the current operation, and thus do not appear on the Nonconformance Screen accessible from the Lot Contents screen. Also, if these parts do not have other, active nonconformances on them, they will have a status of "OK" until they reach an operation to which a nonconformance has been deferred.

The Deferred Nonconformance Screen displays for a lot each part which has a nonconformance which has been deferred to a future operation. It displays the operation at which the nonconformance was detected, and the operation to which it has been deferred. This screen is invoked from the Current Lots Screen.

Fields:

1. Part Number: The part number of the lot being investigated. Display only.
2. Lot Number: The lot number of the lot being investigated. Display only.
3. Operation: The current operation for the lot being investigated. Display only.
4. Part ID: The serial or temporary number of the defective parts in the lot. Display only.
5. Characteristic: The characteristic number of the nonconformance for each part. Display only.
6. Operation Detected: The operation at which the nonconformance occurred. Display only.
7. Operation Deferred: The operation which the nonconformance has been deferred to. Display only.

Menu Options

1. QOIDisp  
Brings up the QOI display for the characteristic selected.
2. Notes  
Brings up the Notepad for the operation selected.

#### 4.4.3.4 Split Lot

AQAS	Split Lot	12-AUG-87
Part Number: 718371	QOI Rev: 01	
Operation Number: 00042	Lot Number: A111- 11	Qty: 20
Quantity to Split:		
Of those, number left to process:		
Number of unprocessed parts left behind:		
Split Lot Number: XXXX-XXX		
PART ID		
XXXXXX		
scroll		
scroll		
scroll		
User: John Doe		
split lost-parts		

#### Description:

This display allows the user to split off parts for a new lot, or to report lost parts. For either menu choice, the user will be prompted for a password to authorize the split.

#### Fields:

1. Part Number  
This field gives the part number for the lot-operation listed.
2. Lot Number  
Shows the lot number for the lot-operation listed.
3. Operation  
Shows the operation for the lot-operation listed.
4. QOI Revision  
Shows the QOI Revision used for the lot-operation listed.

5. Qty  
Shows the number of parts in the lot before splitting.
6. Split Lot Quantity  
The number of parts going into the new lot.
7. Of those, quantity left unprocessed  
The number of unprocessed parts moved to the new lot. This is used to manage proper auditing of the parts.
8. Number of unprocessed parts left behind  
The number of unprocessed parts left in the old lot. This is used to manage proper auditing of the parts.
9. Split Lot Number  
The lot number to be assigned to the new split. This is only required for splits. No lot number is used to report lost parts.
10. Part ID  
A list of serial numbers or temporary numbers to be placed in the new lot. The user may enter either serial numbers or temporary numbers, but not both.

Menu Options:

1. Split  
This splits the lot into a normal production lot.
2. Lost-parts  
This reports the listed parts as lost.

#### 4.4.3.5 Non-Conformance Record

AQAS		Non-Conformance Record			12-AUG-87
Part Number: 718371		QOI Rev: 01			
Operation Number: 00042		Lot Number: A111- 11			
Part ID:1		Op detected at: 00042			
Characteristic	Operator	Inspector	Maximum	Minimum	
0001	1.001	1.002	1.000	0.995	
User: John Doe					
Resolve_Menu Instructs Scrap MRB-Split					
In-Process Rework Void MRB-Accept Defer					(resolve)

#### Description:

This display shows information about a particular non-conforming part. It lists the characteristics which are out of tolerance, and gives the measurements taken for them.

The user may resolve the non-conformance on this part from this screen.

Fields:

1. Part Number  
This field gives the part number for the lot-operation listed.
2. Lot Number  
Shows the lot number for the lot-operation listed.
3. Operation  
Shows the operation for the lot-operation listed.
4. QOI Revision  
Shows the QOI Revision used for the lot-operation listed.
5. Part ID. A serial number or temporary number for the non-conforming part.
6. Characteristic. A characteristic for which this part is out-of-tolerance.
7. Detected at. The operation at which this non-conformance was detected.
8. Min Dimension. The minimum dimension from the QOI data base for this characteristic. Display only.
9. Max Dimension. The maximum dimension from the QOI data base for this characteristic. Display only.
10. Field with no header, immediately after the two results fields. Shows oversize (O/S) or Undersize (U/S). Scroll display only.
11. Inspector. 8 character field displaying the inspector's result. Display only.
12. Operator. 8 character field displaying the operator's result. This field only appears on the inspector's data collection screen. Display only.

Menu Options:

1. In-Process  
Accept this part. The non-conformance will be corrected as part of normal processing at later operations.
2. Rework  
Accept this part. Minor rework has corrected the problem. The user will be prompted for a reworked characteristic measurement.



3. Void  
Accept this part. The non-conformance has been determined to be void.
4. MRB-Accept  
Accept this part. The MRB review has corrected the problem. The user will be prompted for the NMR number and reworked characteristic measurement.
5. Defer  
Accept this part. The problem will be investigated later. The user will be prompted for the operation to which to defer the non-conformance.
6. Instructs  
Bring up the instructions menu.
7. Scrap  
Reports the scrapping of this part. The user will be prompted for the scrap tag number.
8. MRB-Split  
Send this part to the MRB Area. The user will be prompted for the NMR number.

[illegible]

This screen is used to change the serial numbers and/or heat codes associated with an existing lot. It is intended to be used only for correcting mistakes made when the serial numbers and/or heat codes were originally typed in.

To change a serial number or heat code, the user scrolls to the field which he wishes to change, and types the new number in over the old number. The same checking for duplicates which is done when a new serial number is typed in is also performed here.

When the Supervisor/Engineer is done correcting their data, he selects LockChanges to commit the changes to the database. At that time he will be prompted to verify that he does indeed want to override the existing data. If he responds yes, all references to the modified serial number and/or heat code in the AQAS database are changed to the new one. The old serial number, new serial number, date of change and the name of the person who made the change are recorded in the serial number change log in the AQAS database.

Fields:

1. Part Number. 20 Character display field obtained from the previous display. Display only.
2. Lot Number. The parent four character lot number and the split number are displayed from the previous screen. Display only.
3. Part Quantity. Up to 6 digit display field obtained from the previous screen.
4. Serial Numbers. 15 characters maximum. Standard format is AAAnnnn. Optional format: AAAnnnnA. Longer formats are possible. Scroll display/entry area where serial numbers are entered for the lot. Serial numbers are checked against an AQAS serial number domain table.
5. Heat Code / Lot. 20 characters maximum. Entry of the heat code or serial number to be associated with each serialized part. Scroll display/entry.

Menu Options:

1. LockChanges  
Stores the changes to the serial numbers and/or heat codes in the AQAS database. A warning is displayed that these changes are about to be made permanent and the user can either continue and make the changes, or go back and edit some more before making the changes permanent.

#### 4.4.5 Change Lot Quantity

AQAS	Change Lot Quantity	12-AUG-87
Part Number: 12345678901234567890		
Lot Number: A234- 12		
Lot Quantity: 50		
Serial Numbers XXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXX		
User: John Doe IncreaseQty DecreaseQty		

#### Description:

This screen is used to adjust the quantity of serialized or unserialized lots. It might be used to account for extra parts being cut from bar stock, or for errors in counting a large lot.

To change the quantity of parts in the lot, the user selects "IncreaseQty" or "DecreaseQty". He may increase the qty of either serialized or unserialized lots. He may decrease the quantity of unserialized lots only. If he wants to report specific parts as lost, he should use the "Lost-Parts" option in the split screen.

AQAS prompts the user for the quantity of the adjustment. It then asks for a password verification to ensure that only Quality Engineers and Supervisors perform this task.

Fields:

1. Part Number. 20 Character display field obtained from the previous display. Display only.
2. Lot Number. The parent four character lot number and the split number are displayed from the previous screen. Display only.
3. Part Quantity. Up to 6 digit display field obtained from the previous screen.
4. Serial Numbers. 15 characters maximum. Standard format is AAAnnnn. Optional format: AAAnnnnA. Longer formats are possible. Scroll display/entry area where serial numbers are entered for the lot. Serial numbers are checked against an AQAS serial number domain table.

Menu Options:

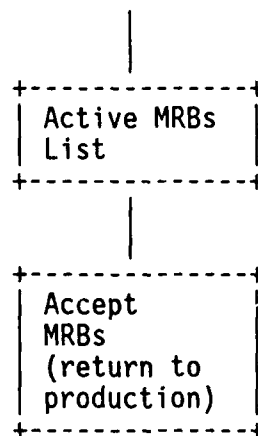
1. IncreaseQty  
Allows the user to increase the number of parts in the lot.
2. DecreaseQty  
Allows the user to decrease the number of parts in the lot.

#### 4.4.6 Remove Parts From MRB Status Branch

This branch of the Quality Engineer / Supervisor Interface is used to bring parts back from the list of parts which have been split from lots for MRB study.

For example, if a supervisor wants to form a new lot-split from three parts which have been split for MRB study, he should use this branch. He first looks at the "Active MRB List" to see that the AQAS system does indeed think these parts are in MRB. He then "accepts" those parts back into a new production lot-split, using the "Accept Lot from MRB" screen. It is supervisor's responsibility to make sure that these parts have indeed been cleared through the MRB system. AQAS only knows that the parts have been split off for MRB. It cannot know what action has been taken during MRB study.

This branch can also be used to give a supervisor a list of MRB'ed parts. The listed parts can be accepted as a new lot-split (as described above), left in MRB, or reported as "rejected". The supervisor should "reject" all parts which have been scrapped or returned to vendor. Otherwise, these parts will stay on the list for up to a year before being removed.



REMOVE PARTS FROM MRB STATUS BRANCH

#### 4.4.6.1 Active MRB List

AQAS		Active MRB List				12-AUG-87
	Serial No.	Temp No.	Part No.	Lot	Create Date	Operation
X	CT1055		718371	A111- 11	12-JAN-88	00042
X	CT1062		718371	A111- 11	12-JAN-88	00042
	CT1054		718371	A111- 11	17-JAN-88	00050
	.	.	.	.	.	.
	.	.	.	.	.	.
	.	.	.	.	.	.
	.	.	.	.	.	.
	.	.	.	.	.	.
	.	.	.	.	.	.
	.	.	.	.	.	.
	.	.	.	.	.	.
	.	.	.	.	.	.
	.	.	.	.	.	.
	.	.	.	.	.	.
User: John Doe						
AcceptLot Detail						

#### Description:

This display shows the parts in MRB review. The user marks some parts and then selects "AcceptLot" to accept them as a new lot, or "detail" to view a detailed nonconformance report and resolve individual nonconformances.

If he selects "accept", the AQAS system verifies that the group of parts are all from the same parent lot. If not, a warning message is displayed and no action is taken. If the parts are all from the same parent lot, the "Accept Parts" screen is displayed, allowing the user to assign a new lot number to the group of parts.

Fields:

1. (Leftmost field)  
This field is used to mark lines of data for further action. If a user wants to accept back into production certain parts, he marks the corresponding lines of data and selects the "accept" option. If he wants to reject certain parts, he marks those lines and selects "reject".
2. Serial No.  
Shows the serial number for the part, if any.
3. Temp No.  
This field shows the temporary number for the part.
4. Part Number  
This field gives the part number for the part listed.
5. Lot  
Shows the lot number from which the part was split.
6. Operation  
Shows the operation the lot was in when this part was split to MRB.
7. Create Date  
Shows the date on which this part was split off for MRB.

Menu Options:

1. Accept  
Brings up the accept parts display.
2. Detail  
Brings up the Nonconformance Report screen.



#### 4.4.6.2 Accept Lot From MRB

AQAS		Accept Lot from MRB			12-AUG-87
Serial No.	Temp No.	Part Num	Lot Num	Create Date	Operation
CT1055		718371	A111- 11	12-JAN-88	00042
CT1062		718371	A111- 11	12-JAN-88	00042
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

Part Number: XXXXXXXX                      Lot Number: XXXX- XX

User: John Doe  
accept-lot

#### Description:

This display shows the parts in a new lot to be formed. The user should verify the identity of the parts, enter the part and lot numbers, and select "accept-lot" to create a new lot from these parts.

#### Fields:

1. Part ID  
Shows the serial number for the part, if any. If there is no serial number, this field shows the temporary number for the part.
2. Type  
This field tells the type of part ID given. The possible values are "Serial" and "Temporary".
3. Part Number  
This field gives the part number for the part listed.

4. Lot  
Shows the lot number from which the part was split.
5. Operation  
Shows the operation the lot was in when this part was split to MRB.
6. Create Date  
Shows the date on which this part was split off for MRB.
7. Part Number (new)  
The user enters the new part number here. This is used only in the unusual case where a part changes part number due to a rework operation. Otherwise, the original part number is assumed.
8. Lot Number (new)  
The user enters the new lot number here.

Menu Options:

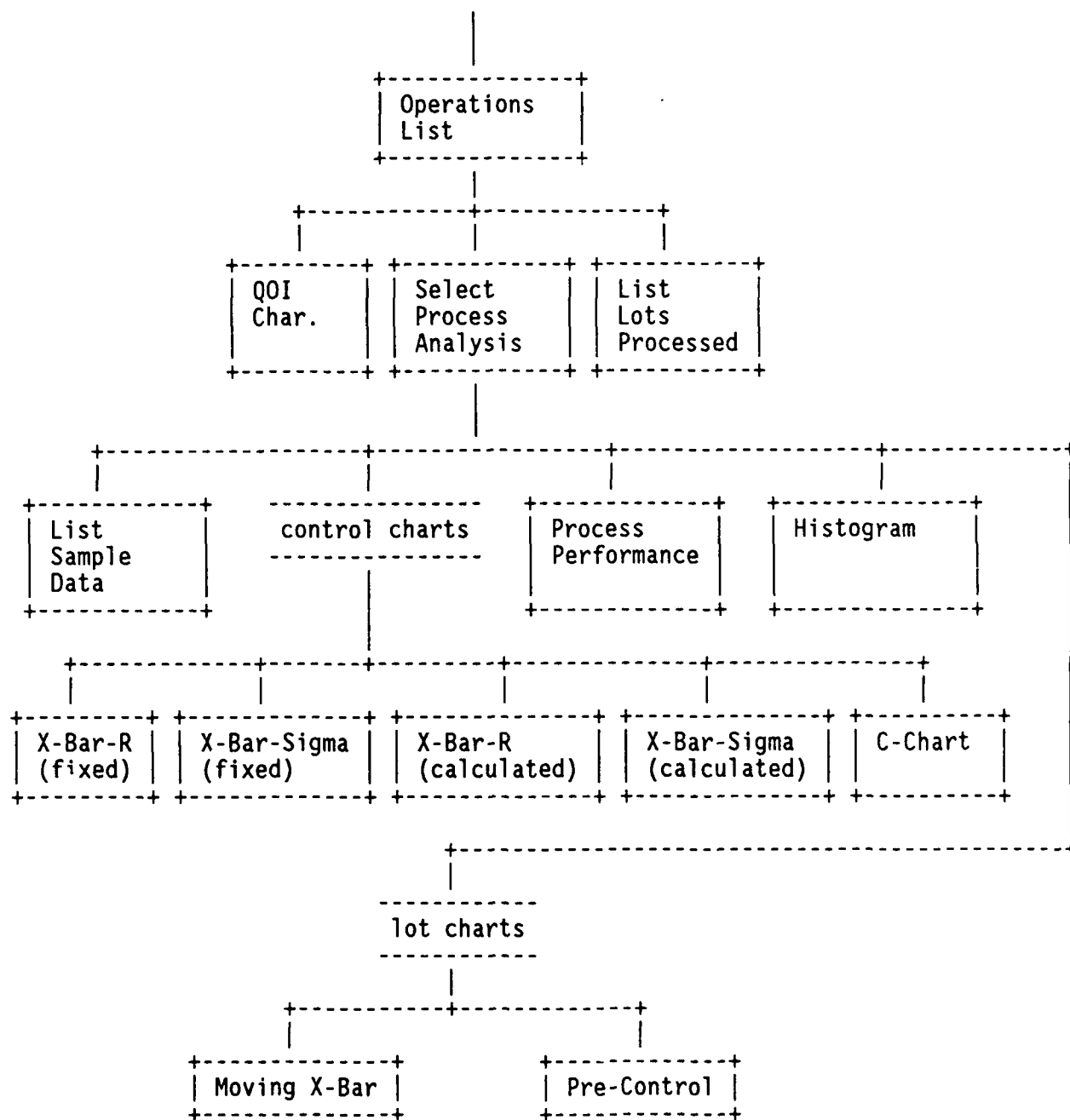
1. Accept-lot  
Creates a new lot out of these parts. The user will be prompted for reworked characteristic measurement.

#### 4.4.7 Analyze Process Control Branch

This branch is used to study operations: to see if they are in control, to see if they are capable of producing quality parts, to find troublesome operations.

A quality engineer can use this branch to look for long range problems in operations. He can call up control charts for the operations, or view summaries of the process capabilities.

This branch is not used to solve individual non-conformance situations. It would, however, be used in an investigation of a pattern of non-conformances.



ANALYZE PROCESS CONTROL BRANCH

AQAS		Operations List		12-AUG-87
Part Number	Operation	QOI	Revision	
718371	00055	A01		
718371	00058	B02		
.	.	.		
.	.	.		
.	.	.		
.	.	.		
.	.	.		
.	.	.		
.	.	.		
.	.	.		
.	.	.		
.	.	.		
.	.	.		

User: John Doe  
QOI Lots Analysis

This display shows the part/operations that AQAS knows about. Note that the current QOI revision for the part/operation is shown.

**Fields:**

1. **Part Number**  
This field gives the part number for the lot-operation listed.
2. **Operation**  
Shows the operation for the lot-operation listed.

3. QOI Revision  
Shows the QOI Revision used for the lot-operation listed.

Menu Options:

1. QOI  
Show the QOI instructions for the selected operation.
2. Lots  
Show the list of lots that have been processed through this operation.  
The Lots-List display will prompt the user for a beginning and end date.
3. Analysis  
Bring up the Select Process Analysis display.

4.4.7.2 QOI Display

See Operator/Inspector Interface.

4.4.7.3 Lots List

AQAS	Lots List				12-AUG-87
Earliest Date: XXXXXXXXXX		Latest Date: XXXXXXXXXXXXXXXX			
Part Number: 718371		Operation: 00055			
Lot Number	QOI Revision	Date Started	Quantity	Non-Confs	
.	.	.	.	.	
.	.	.	.	.	
.	.	.	.	.	
.	.	.	.	.	
.	.	.	.	.	
.	.	.	.	.	
.	.	.	.	.	
.	.	.	.	.	
User: John Doe					
AcquireData					

Description:

This display shows the lots that have passed through the operation during the period shown.

Fields

1. Earliest Date  
The beginning date of the period of study.
2. Latest Date  
The final date of the period of study.
3. Part Number  
This field gives the part number for the lot-operation listed.
4. Lot Number  
Shows the lot number for the lot-operation listed.
5. Operation  
Shows the operation for the lot-operation listed.
6. QOI Revision  
Shows the QOI Revision used for the lot-operation listed.
7. Date Started  
Shows the date this lot was first reported at this operation.
8. Quantity  
Shows the number of parts in the lot.
9. Non-Confs  
Shows the number of non-conformances reported for this lot.

Menu Options:

1. AcquireData  
This selection pulls the list of lots processed for the period entered.

#### 4.4.7.4 Select Process Analysis

AQAS	Select Process Analysis	12-AUG-87
Part Number: 718371                      Operation: 00055		
Characteristic: XXXXXX		
Earliest Date: XXXXXXXXXX              Latest Date: XXXXXXXXXXXX		
Operator: XXXXXX		
Gage Number: XXXXXXXXXXXXXXXXXXXX		
Machine Number: XXXXXXXX		
User: John Doe		
Sample-List   Process-Performance Histogram   Control-Chart   Lot-Chart		

#### Description:

This display is used to specify a characteristic, time period, and type of analysis.

#### Fields

1. Part Number  
This field gives the part number for the lot-operation listed.
2. Operation  
Shows the operation for the lot-operation listed.
3. Characteristic. A characteristic to be studied.
4. Earliest Date  
The beginning date of the period of study.



5. Latest Date  
The final date of the period of study.
6. Operator  
The badge number of the operator who took the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements made by any operator will be considered.
7. Gage Number  
The gage number of the gage used to take the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements taken with any gage will be considered.
8. Machine Number  
The machine number of the machine used to take the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements taken with any machine will be considered.

Menu Options:

1. Sample-List  
Brings up a list of sample data for the characteristic and period given.
2. Process-Performance  
Brings up an analysis of process performance for the characteristic and period given.
3. Histogram  
Brings up a histogram of x-bar values for the characteristic and period given.
4. Control-Chart  
Brings up a choice of
  - Range-X-Bar
    - Calculated-Limits
    - Fixed-Limits
  - Sigma-X-Bar
    - Calculated-Limits
    - Fixed-Limits
  - C-Chart
5. Lot-Chart  
Brings up a choice of pre-control and moving X-Bar-R charts for the latest lot processed through this operation.

#### 4.4.7.5 Sample Data List

AQAS	Sample Data List				12-AUG-87
Part Number: 718371		Operation: 00055			
Characteristic: 10		Machine: 12355			
Earliest Date: 01-JAN-87		Latest Date: 01-AUG-87			
Operator:		Gage Number:			
Minimum: 0.0050		Maximum: 0.0060			
Lot Number	Date	Count	Reading	Skip	
A111- 11	10-AUG-87	1	0.00551		
.	.	.	.		
.	.	.	.		
.	.	.	.		
.	.	.	.		
.	.	.	.		
.	.	.	.		
.	.	.	.		
.	.	.	.		
User: John Doe					
storechange					

#### Description:

This display lists the measurements taken that match the search criteria given. The user may mark certain measurements to be skipped. Skipped measurements will not be considered in subsequent calculations of control limits for this process. If, at a later date, the user determines that a skipped measurement should again be considered for control limit calculations, he may "unmark" the measurement.

#### Fields

1. Part Number  
This field gives the part number for the lot-operation listed.
2. Operation  
Shows the operation for the lot-operation listed.
3. Characteristic. A characteristic to be studied.

4. Earliest Date  
The beginning date of the period of study.
5. Latest Date  
The final date of the period of study.
6. Minimum  
The lower tolerance value for the characteristic.
7. Maximum  
The upper tolerance value for the characteristic.
8. Operator  
The badge number of the operator who took the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements made by any operator will be considered.
9. Gage Number  
The gage number of the gage used to take the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements taken with any gage will be considered.
10. Machine Number  
The machine number of the machine used to take the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements taken with any machine will be considered.
11. Skip  
This field is used to mark samples with "assignable causes". These data will not be used in generating control limits for the characteristic.
12. Date  
The date the sample was completed.
13. Count  
The number of the reading within the lot.
14. Reading  
The value of the measurement taken.

Menu Options:

1. StoreChange  
Locks the changes to the "skip" column into the database.

#### 4.4.7.6 Process Performance

AQAS	Process Performance	12-AUG-87
Part Number: 718371	Operation: 00055	
Characteristic: 10	Machine: 12355	
Earliest Date: 01-JAN-87	Latest Date: 01-AUG-87	
Operator:	Gage Number:	
Minimum: 0.0050	Maximum: 0.0060	
Midpoint: (calculated)		
Process Mean: (calc)	Skewness: (calc)	Kurtosis: (calc)
Percent of Limits Utilized: (calc)	Actual: (calc)	
(6 sigma/width of limits)		
Standard Deviation (sigma): (calc)		
Process Capability (6 sigma): (calc)		
Statistical Risk		
of oversize: (calc)		
of undersize: (calc)		
of oversized if centered: (calc)		
User: John Doe		

#### Description:

This display shows important measures of process performance. The numbers are calculated from the means and standard deviations stored for the operation.

#### Fields

1. Part Number  
This field gives the part number for the lot-operation listed.
2. Operation  
Shows the operation for the lot-operation listed.
3. Characteristic. A characteristic to be studied.
4. Earliest Date  
The beginning date of the period of study.

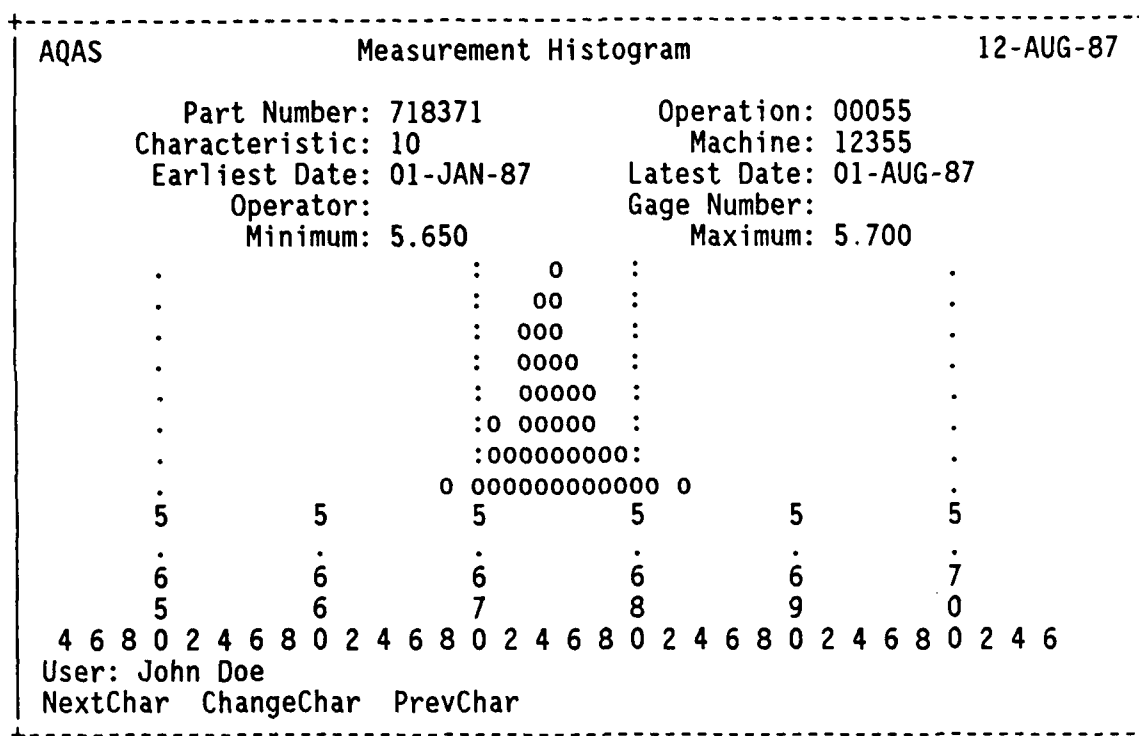
5. Latest Date  
The final date of the period of study.
6. Operator  
The badge number of the operator who took the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements made by any operator will be considered.
7. Gage Number  
The gage number of the gage used to take the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements taken with any gage will be considered.
8. Machine Number  
The machine number of the machine used to take the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements taken with any machine will be considered.
9. Minimum  
The lower tolerance value for the characteristic.
10. Maximum  
The upper tolerance value for the characteristic.
11. Midpoint  
The value half way between minimum and maximum tolerance.
12. Process Mean  
The mean of the measurements.
13. Skewness  
A measure of how unbalanced the measurement distribution is.
14. Kurtosis  
A measure of how flat or pointed the measurement distribution is.
15. Percent of Limits Utilized  
The ratio of the 6-sigma spread of the measurements to the tolerance range of the process.
16. Actual Percent of Limits Utilized  
The ratio of the range of measurements to the tolerance range of the process.
17. Standard Deviation  
The calculated value of sigma of the samples.
18. Process Capability  
the calculated 6-sigma range of the process.

19. Statistical Risk of Oversize  
The calculated chance of generating an oversized part based on the process mean, sigma, and tolerances.
20. Statistical Risk of Undersize  
The calculated chance of generating an undersized part based on the process mean, sigma, and tolerances.
21. Statistical Risk of Oversize If Centered  
The calculated chance of generating an oversized/undersized part based on the process sigma, and tolerances, assuming the process mean were adjusted to match the midpoint of the tolerances.

Menu Options:

1. None

#### 4.4.7.7 Measurement Histogram



#### Description:

This is a histogram of measurement samples for the operation. The vertical lines show the relative position of the 3-sigma limits of the process and the process limits.

#### Fields:

1. Part Number  
This field gives the part number for the lot-operation listed.
2. Operation  
Shows the operation for the lot-operation listed.
3. QOI Revision  
Shows the QOI Revision used for the lot-operation listed.

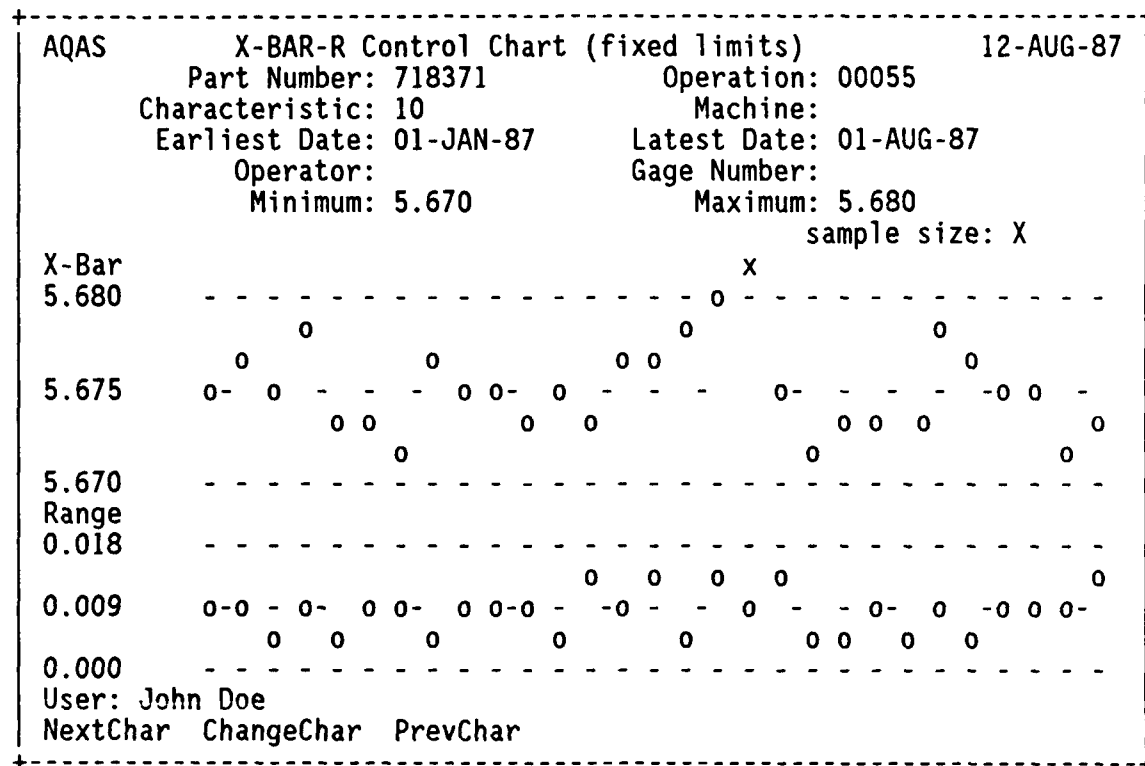
4. Characteristic. A characteristic to be studied.
5. Operator  
The badge number of the operator who took the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements made by any operator will be considered.
6. Gage Number  
The gage number of the gage used to take the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements taken with any gage will be considered.
7. Machine Number  
The machine number of the machine used to take the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements taken with any machine will be considered.

Menu Options:

1. NextChar  
Shows the histogram for the next characteristic.
2. ChangeChar  
Prompts the user for a new characteristic number. Shows the histogram for that characteristic.
3. PrevChar  
Shows the histogram for the next lower characteristic number.



4.4.7.8 X-BAR-R Control Chart (fixed Limits)



Description:

This is an X-BAR-RANGE control chart. It shows the average and range for the last thirty sample groups for this characteristic. The limits shown on this chart are based on the process limits stored in the QOI data.

Fields:

1. Part Number. 20 characters. The part number of the operation being studied.
2. QOI Rev. 2 characters. The QOI revision used for the operation. Obtained from the QOI database. Display only.
3. Operation Number. 7 characters. The operation number being studied.

4. Characteristic. 4 characters. The characteristic being studied.
5. Start. Date. The beginning date for the time period being studied.
6. Finish. Date. The ending date for the time period being studied.
7. Operator  
The badge number of the operator who took the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements made by any operator will be considered.
8. Gage Number  
The gage number of the gage used to take the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements taken with any gage will be considered.
9. Machine Number  
The machine number of the machine used to take the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements taken with any machine will be considered.
10. Sample Size. Integer. The sample size used for this operation.
11. Chart Region. This area is a graphic representation of a control chart. Out-of-control points are shown in a contrasting color and/or shape. The control limits are also shown in this region. Displays last 40 groups for the time period under study.

Menu Options:

1. NextChar  
Shows the control chart for the next characteristic.
2. ChangeChar  
Prompts the user for a new characteristic number.
3. PrevChar  
Shows the control chart for the next lower characteristic number.

```

AQAS      X-BAR-SIGMA Control Chart (fixed limits)      12-AUG-87
Part Number: 718371      Operation: 00055
Characteristic: 10      Machine:
Earliest Date: 01-JAN-87      Latest Date: 01-AUG-87
Operator:      Gage Number:
Minimum: 5.670      Maximum: 5.680
                        sample size: X

X-Bar
5.680      - - - - - x - - - - -
           0           0           0
           0           0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
5.675      0- 0 - - - 0 0- 0 - - - 0- - - - -0 0 -
           0 0           0 0           0 0 0 0 0
5.670      - - - - -
Sigma
0.006      - - - - -
           0           0 0 0 0 0 0 0 0
0.003      0-0 - 0- 0 0- 0 0-0 - -0 - - - -0- 0 -0 0 0-
           0           0 0 0 0 0 0 0 0
0.000      - - - - -
User: John Doe
NextChar ChangeChar PrevChar

```

This is an X-BAR-SIGMA control chart. It is similar to an X-BAR-R chart, except that it shows the standard deviation (sigma) instead of the range of measurements within each sample group. The limits shown on this chart are based on the process limits stored in the QOI data.

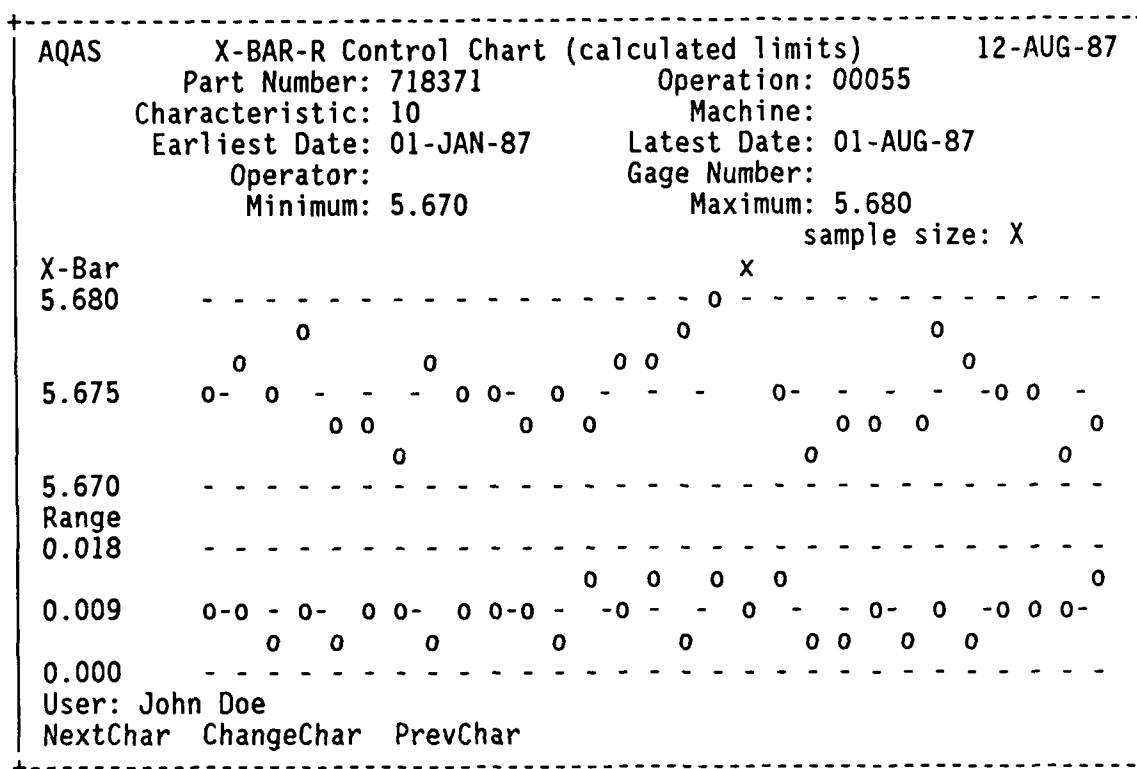
1. Part Number. 20 characters. The part number of the operation being studied.
2. QOI Rev. 2 characters. The QOI revision used for the operation. Obtained from the QOI database. Display only.
3. Operation Number. 7 characters. The operation number being studied.

4. Characteristic. 4 characters. The characteristic being studied.
5. Operator  
The badge number of the operator who took the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements made by any operator will be considered.
6. Gage Number  
The gage number of the gage used to take the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements taken with any gage will be considered.
7. Machine Number  
The machine number of the machine used to take the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements taken with any machine will be considered.
8. Start. Date. The beginning date for the time period being studied.
9. Finish. Date. The ending date for the time period being studied.
10. Sample Size. Integer. The sample size used for this operation.
11. Chart Region. This area is a graphic representation of a control chart. Out-of-control points are shown in a contrasting color and/or shape. The control limits are also shown in this region. Displays last 40 groups for the period under study.

Menu Options:

1. NextChar  
Shows the control chart for the next characteristic.
2. ChangeChar  
Prompts the user for a new characteristic number.
3. PrevChar  
Shows the control chart for the next lower characteristic number.

4.4.7.10 X-BAR-R Control Chart (calculated Limits)



Description:

This is an X-BAR-RANGE control chart. It shows the average and range for the last thirty sample groups for this characteristic. The limits shown on this chart are calculated from the sample data.

Fields:

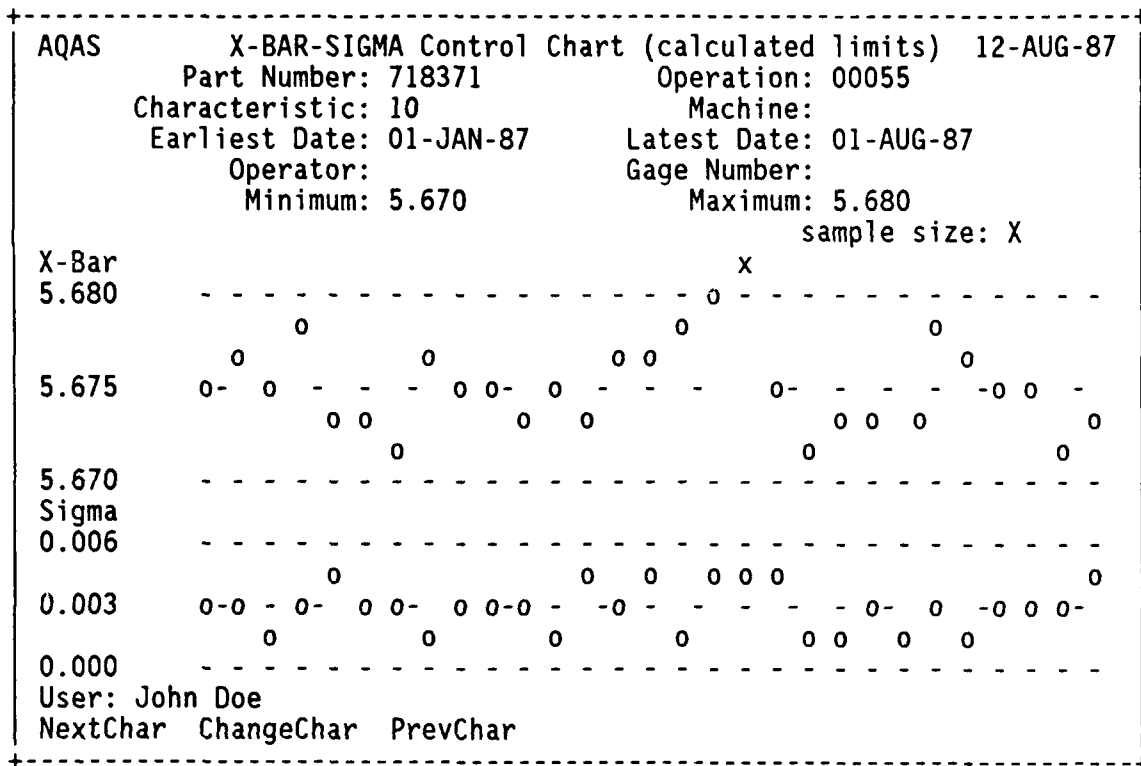
1. Part Number. 20 characters. The part number of the operation being studied.
2. QOI Rev. 2 characters. The QOI revision used for the operation. Obtained from the QOI database. Display only.
3. Operation Number. 7 characters. The operation number being studied.

4. Characteristic. 4 characters. The characteristic being studied.
5. Operator  
The badge number of the operator who took the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements made by any operator will be considered.
6. Gage Number  
The gage number of the gage used to take the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements taken with any gage will be considered.
7. Machine Number  
The machine number of the machine used to take the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements taken with any machine will be considered.
8. Start. Date. The beginning date for the time period being studied.
9. Finish. Date. The ending date for the time period being studied.
10. Sample Size. Integer. The sample size used for this operation. This can be entered or an operation default can be used.
11. Chart Region. This area is a graphic representation of a control chart. Out-of-control points are shown in a contrasting color and/or shape. The control limits are also shown in this region.

Menu Options:

1. NextChar  
Shows the control chart for the next characteristic.
2. ChangeChar  
Prompts the user for a new characteristic number.
3. PrevChar  
Shows the control chart for the next lower characteristic number.

4.4.7.11 X-BAR-SIGMA Control Chart (calculated Limits)



Description:

This is an X-BAR-SIGMA control chart. It is similar to an X-BAR-R chart, except that it shows the standard deviation (sigma) instead of the range of measurements within each sample group. The limits shown on this chart are calculated from the sample data.

Fields:

1. Part Number. 20 characters. The part number of the operation being studied.
2. QOI Rev. 2 characters. The QOI revision used for the operation. Obtained from the QOI database. Display only.
3. Operation Number. 7 characters. The operation number being studied.

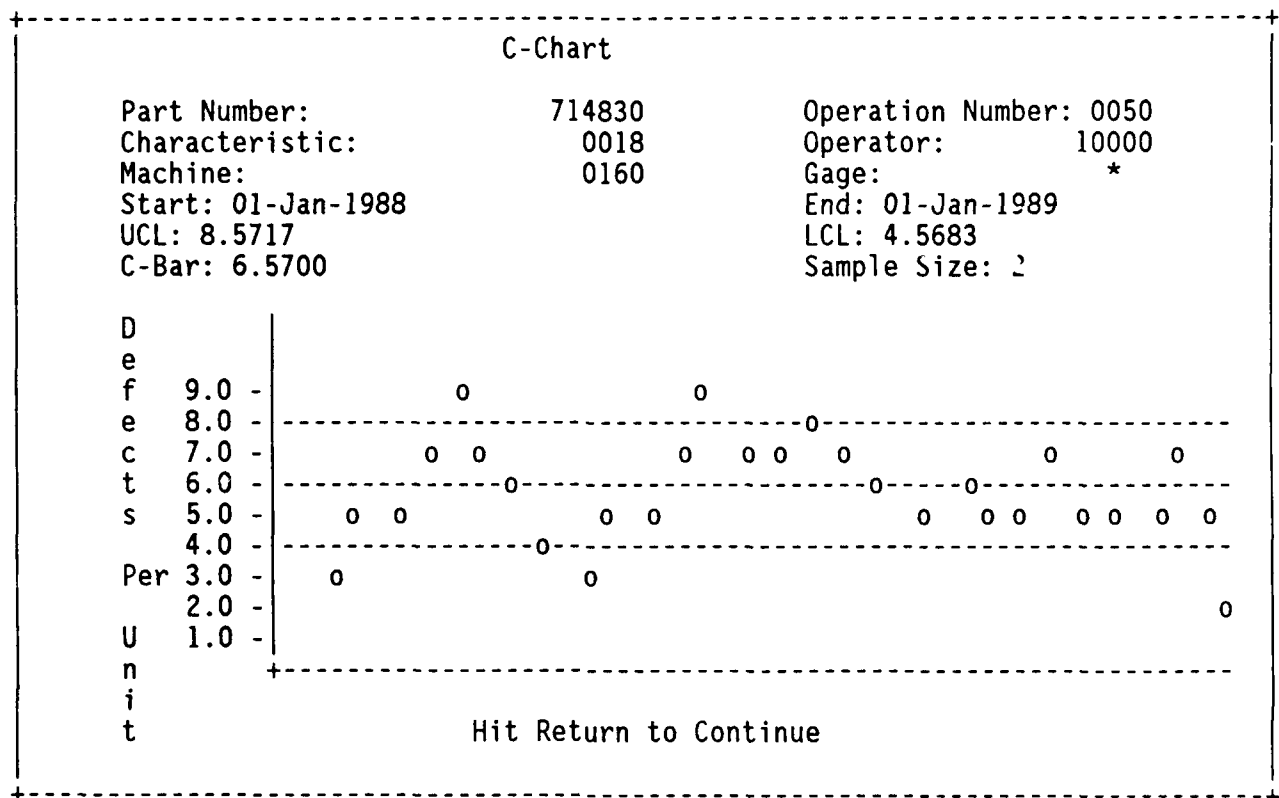
4. Characteristic. 4 characters. The characteristic being studied.
5. Operator  
The badge number of the operator who took the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements made by any operator will be considered.
6. Gage Number  
The gage number of the gage used to take the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements taken with any gage will be considered.
7. Machine Number  
The machine number of the machine used to take the measurements. If this field is filled, the analysis will be made on these measurements only. Otherwise, measurements taken with any machine will be considered.
8. Start. Date. The beginning date for the time period being studied.
9. Finish. Date. The ending date for the time period being studied.
10. Sample Size. Integer. The sample size used for this operation. This can be entered or an operation default can be used.
11. Chart Region. This area is a graphic representation of a control chart. Out-of-control points are shown in a contrasting color and/or shape. The control limits are also shown in this region.

Menu Options:

1. NextChar  
Shows the control chart for the next characteristic.
2. ChangeChar  
Prompts the user for a new characteristic number.
3. PrevChar  
Shows the control chart for the next lower characteristic number.



#### 4.4.7.12 C-Chart



#### Description:

The C-Chart display is a graphic representation of the number of defects per unit. Note that the control limits, and points outside the control limits appear in red on a color terminal, and the mean and points within the control limits appear in green. Also please note that the figure above is a textual representation of a graphic screen, and the final screen will not look exactly like it. The data represented, however, will be the same.

The basic unit used here will be a measurement. This unit is used because with unserialized parts, it is impossible to trace a measurement back to the part it was taken on. The following are the calculations used for the C-Chart:

- n = sample size
- k = number of sample groups (up to 40 displayed)
- C = number of defects in the sample group

$$\bar{C} = (C_1 + C_2 + \dots + C_k) / k$$

$$C_{uc1} = \bar{C} + 3 * \text{SQRT}(\bar{C})$$

$$C_{lc1} = \bar{C} - 3 * \text{SQRT}(\bar{C})$$

The data which appear on the chart are:

- o Each point represents C for a sample group
- o The top line represents  $C_{uc1}$
- o The middle line represents  $\bar{C}$
- o The bottom line represents  $C_{lc1}$

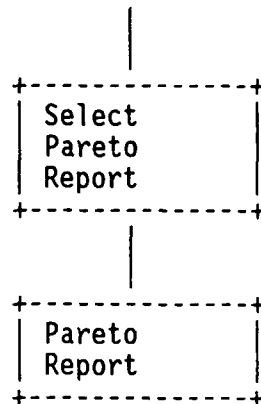
Fields:

1. Part Number: The part number being investigated. Display Only
2. Operation: The operation number being investigated. Display Only.
3. Characteristic: The QOI characteristic number being investigated. Display only.
4. Machine: The machine number being investigated. Display only.
5. Operator: The operator badge number being investigated. Display only.
6. Gage: The gage number being investigated. Display only.
7.  $C_{uc1}$ : Upper control limit for C. Display only
8.  $C_{lc1}$ : Lower control limit for C. Display only.
9. Sample size: The sample size used for display and calculations. Display only.
10.  $\bar{C}$ : (Middle number on vertical axis) Average C for sample groups. Display only.

#### 4.4.8 Generate Non-Conformance Pareto Report Branch

This branch is used to pinpoint trouble areas through the use of Pareto Reports. These reports relate the incidence of non-conforming measurements to a number of different categories. These reports do not automatically identify causes, but instead find relationships. For instance, a large concentration of non-conformances on one operator may be an indication that he needs more training, or it may be an indication that he is the most experienced operator and is therefore assigned to the troublesome machine.

Only one screen is shown here, although it is expected that two will actually be needed. The first will allow the user to specify what kind of report he wants. The second will show the report.



GENERATE NON-CONFORMANCE PARETO REPORT BRANCH

[illegible]

This is a Pareto chart showing the number of non-conformances broken down into certain divisions. The user may specify a domain to be analyzed and how the data should be divided.

- All measurements
- measurements on a part number

- measurements on a part/operation
- measurements on a work center
- measurements on a particular machine
- measurements on a characteristic
- any range of dates

Valid divisions are:

- part
- operation
- work center
- machine
- gage
- operator
- characteristic
- day
- week
- month

Fields:

1. Part Number. 20 characters. The part number of the operation being studied.
2. Operation Number. 7 characters. The operation number being studied.
3. Work Center. 6 characters. The work center being studied (if any).
4. Machine. The individual machine being studied (if any).
5. Characteristic. The specific characteristic being studied (if any).

6. Start Date. The beginning of the period of study.
7. End Date. The end of the period of study.
8. Division - the categories into which the non-conformances are broken down. For this display, the divisions are determined by the menu choice. At most ten divisions are shown. (Nine most common and one "other" division)
9. Number of Non-Conformances - the number of non-conformances for the given division. This is a count of non-conforming measurements, as opposed to non-conforming parts.

Menu Options:

1. Part  
All menu options are choices of how to divide the data.
2. Operation
3. Work center
4. Machine
5. Gage
6. Operator
7. Characteristic
8. Day
9. Week
10. Month

#### 4.4.9 Request External File Information To Be Read Into AQAS Branch

This branch consists of one screen that is used to accept a new set of QOI, Part-Lot, and Gage Calibration data.

#### 4.4.9.1 Accept File Download Screen

AQAS	Accept File Download	07-DEC-87
Reading file CORP_DNLOAD from directory AQAS_DNLOAD		
Begin reading file 11:01		
No errors detected		
File read complete 11:07		
User: John Doe		
Done		

#### Description:

Normally, all the files necessary for the operators and inspectors to perform their work are downloaded automatically on a once a day basis from the Plant Computer. In some cases, however, there may be a need to obtain a new file or files immediately during the day. In this case, a download can be initiated on the Plant Computer, and this screen can be used to trigger AQAS to read the files.

This screen is used to read a file which has been downloaded from the Plant Computer into the AQAS database. Since there is no direct interprocess communication between AQAS and the Plant Computer, the download of files is triggered from the Plant Computer. In order to get those files into the AQAS database, the Quality Supervisor/Engineer uses this screen.



The Quality Supervisor/Engineer selects the option to "Request External File Information be Read into AQAS". This screen is then displayed. The purpose of this screen is to display error messages and informational messages to the user while the file read takes place. AQAS first checks to be sure that the dates on each record in the file are later than those currently maintained in the database. If they are not, an error is signaled to the Quality Supervisor/Engineer, and the files are not entered into the database. AQAS also checks for an end-of-file marker. If no end-of-file is found, then the file will not be read into the data base. Having an end-of-file marker allows AQAS to verify that the entire file was received and not just a portion of it.

The files are read, and the database is updated according to the record types in the files.

It is anticipated that this screen will not be used frequently, and that in most cases, the automatic download will be used to read files into AQAS which have been downloaded from the Plant Computer.

Fields:

1. user\_message

Menu Options:

1. Done  
Down load has completed, exit this screen.

## 4.5 SYSTEM MANAGER INTERFACE

### 4.5.1 Overview Of The Interface

This document describes the user interface screens which support and maintain the AQAS system and its environment. The System Manager is a person who is concerned with the overall maintenance of the hardware and the software environment, and is not so familiar with the AQAS application itself. The tasks which fall under this category are generally less frequently used, and pertain to the hardware, software and physical environment in which AQAS resides.

In addition to the tasks performed by the AQAS System Manager, some support tasks will be performed by Quality Engineers and Supervisors. These are tasks which require complete knowledge of AQAS and quality, and some familiarity with the support environment (INGRES in particular). These tasks include:

- o Obtaining Emergency Download files from the Plant Computer (see Supervisor/Engineer interface)
- o Using INGRES tools to produce displays and reports.

#### 4.5.2 System Manager Interfaces

This group of screens provides the System Managers with the tools they need to maintain AQAS and support the users. The functions of a system manager include:

1. Maintaining the list of users and user types
2. Maintaining AQAS passwords
3. Maintaining the configuration table which maps the Ethernet and remote ports to physical devices.
4. Maintaining the AQAS Dept/Work Center Machine Domain Table which lists valid Dept/Work Centers and Machine Numbers, along with descriptions of these.
5. Archiving Data on a regular basis (see Chapter 5)
6. Maintaining the data base by using INGRES tools such as Query-by-Forms and Report-by-Forms (see Chapter 5)
7. Managing INGRES accounts and privileges (see Chapter 5)
8. Any other AQAS related maintenance task

Any other functions which the system manager might perform can be done either using DCL command files, or through INGRES SQL for database related tasks.

The access tree (Figure 4-4) illustrates the network of screens available to system managers.

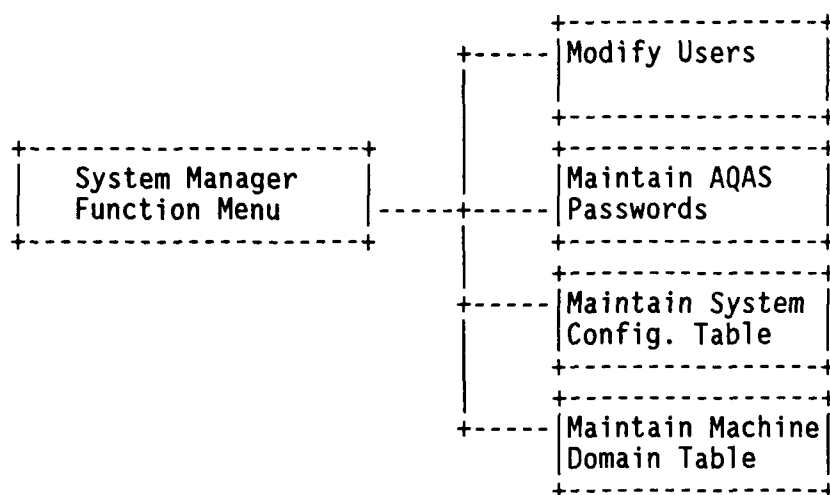


FIGURE 4-4 - SYSTEM MANAGER USER INTERFACE ACCESS TREE

The System Manager needs to be able to perform a number of relatively unrelated functions to maintain the system. Therefore, the system manager interface main screen consists of a menu listing those functions, and a number of screens branching off from it, allowing the user to perform them. The menu is organized in such a fashion that the most often used tasks are listed first, and the least often used last.

#### 4.5.2.1 System Manager Function Menu

AQAS	System Manager Function Menu	07-DEC-87
<ol style="list-style-type: none"><li>1. Maintain Users</li><li>2. Maintain System Configuration Table</li><li>3. Maintain AQAS Passwords</li><li>4. Maintain Dept/Work Center/Machine Domain Table</li></ol>		
Enter Selection: X		
User: John Doe		

#### Description:

This function menu lists the various functions the system manager may need to perform. By selecting the number corresponding to the desired function, the system manager can proceed to the appropriate screen to execute the function.

Because this whole screen is a menu, no menu line appears at the bottom of the screen. When the user enters the number corresponding to his choice, that screen appears immediately.

To make a selection, the user can either select one of the choices, or type in his choice at the bottom.

#### Fields:

1. Menu\_Selection

#### 4.5.2.2 Maintain Users Screen

```

+-----+
| AQAS                Maintain Users                07-DEC-87 |
+-----+
| User Group Displayed: All Users                      |
+-----+
| Badge  User Name      Initial UserClass  Changed  Expires |
+-----+
| 99999  John Doe       JQD                s    12-Aug-1988  12-Aug-1999 |
| 88888  Harold Employee HQE                i    12-Aug-1988  12-Aug-1999 |
| 88888  Harold Employee HQE                e    12-Aug-1988  12-Aug-1999 |
| 77777  Joan Smith     JQS                o    12-Aug-1988  12-Aug-1999 |
+-----+
| User: John Doe                                         |
| Select SaveChg AddUsr Del MaintainPwd                 |
+-----+

```

#### Description:

This screen is used to display and modify user classes. A user may belong to several user classes, and will appear once for each class. A user who belongs to more than one class must specify which class he is currently and may change to any other class he belongs to at any time while using the system. In the sample screen above, for example, Harold Employee is both an Inspector and a Engineer/Supervisor, therefore his name appears twice in the table.

To modify a user's class, the System Manager can type over the existing field. He need only enter:

- o "O" - Operator
- o "I" - Inspector

- o "E" - Engineer/Supervisor
- o "S" - System Manager

The rest of the field will be filled in by the system.

To enter a new user, the System Manager scrolls to a blank line, and enters the user information.

The list of user classes will reside in the database, to make it easier to make modifications to this list.

Fields:

1. Badge #
2. User\_name
3. Initials
4. User\_class
5. Date changed (of password)
6. Expiration date (of password)

Menu Options:

1. Select  
Brings up a choice of groups of users to display.
  1. AllUsers  
Display all AQAS users.
  2. Oper&Insp  
Display only Operators and Inspectors.
  3. Eng/Super  
Display only Engineer/Supervisors

4. SysMan  
Display only System Managers
2. SaveChg  
Save all changes made to this table.
3. AddUsr  
Add a new line for entry.
4. Del  
Delete the selected user.
5. MaintPwd  
Brings up the Maintain Password screen.



#### 4.5.2.3 Maintain System Configuration Table

AQAS Maintain System Configuration Table			07-DEC-87
Application Port Name	Physical Device	Associated Terminal	
LTA100	TERMINAL_A		
LTA101	GAGE_A	TERMINAL_A	
LTA102	scroll	scroll	
LTA103	scroll	scroll	
LTA104	scroll	scroll	
LTA105	scroll	scroll	
SCROLL	scroll	scroll	
User: John Doe			
SaveChg	Ins	Del	

#### Description:

This screen is used by the System Manager to modify the System Configuration Table. This table maps VMS LAT Application Ports to physical devices (terminals, gages, printers, etc.). It also maps gages to associated terminals. An "associated terminal" for a gage is the terminal which is physically closest to it, so that a user logged on to that terminal would use that gage to take measurements. The system maintains this information so that when a user logs on to a certain terminal, AQAS knows what port is near that terminal and can associate a gage with that terminal. The application ports are created and attached to physical ports at system start-up through a DCL command file. This is the only way that application ports can be created. The System Manager is responsible for maintaining that command file and verifying that the mapping is correct. Such a file is already in use in Gainesville at this time. Since this table reflects physical connections, changes to this table should only be made when a device is physically moved from one port to another, or attached or detached from a port, or if for some reason, a different application port mapping is required by the System Manager. Changes to this table must be kept consistent with the system start-up file which creates the application ports.

To make changes to the existing table, the System Manager can simply type over what is already there. To add a new device to the table, the System Manager can scroll to a blank line and enter the information there.

Only gages have associated terminals.

After editing the table, the SaveChanges option must be selected from the menu line to make the changes permanent.

Fields:

1. Applicationport
2. Physical\_device
3. Associated\_terminal

Menu Options:

1. SaveChg  
Save the changes made in this screen.
2. Ins  
Insert a new line.
3. Del  
Delete the machine shown.

#### 4.5.2.4 Maintain AQAS Passwords

AQAS	Maintain AQAS Passwords	07-DEC-87
Enter User Identification:		
Badge Number: 88888		
User Information:		
Name: Harold Employee		
Classes: I E		
Enter New Password: xxxxxxxx		
Verify New Password: xxxxxxxx		
User: John Doe		

#### Description:

The AQAS system maintains its own database of users and passwords separate from VMS. A user is uniquely identified by his badge number. Users other than operators must enter their AQAS passwords to change data in the system.

The System Manager uses this screen to create a new password for a user. He might do this if he has just created a new user account from the Modify Users Screen, or if a user has forgotten his password. The System Manager cannot find out what a user's password is, he can only change it.

The System Manager need only type in the user's Employee Badge ID number. The system will then look up to see if this is a valid badge number and display the user information. User information includes name and classes. If the badge number is not a valid one, the System Manager may not continue in this screen until he enters a valid one.

After the user information has been displayed so the System Manager can be sure that the user is the correct one, he may enter a new password for the user. This password will not be echoed back to the System Manager. This means that the System Manager will not be able to see what he is typing in. Therefore, the password must be typed in a second time to verify that it was typed in correctly.

Operators are not required to have AQAS passwords.

Fields:

1. Badge #
2. User\_name\_last
3. User\_name\_first
4. User\_class
5. New\_password
6. Ver\_password

Menu Options:

1. SaveChanges  
Save the changes made in this screen.

#### 4.5.2.5 Maintain Dept/Work Center And Machine Domain Table

AQAS Maintain Dept/Work Center and Machine Domain Table 07-DEC-87			
Department/ WorkCenter	Machine ID	Default Directory	Description
999999	99999999	CMM1_dir	Description of work center/machine
scroll	scroll	scroll	scroll
scroll	scroll	scroll	scroll
scroll	scroll	scroll	scroll
scroll	scroll	scroll	scroll
scroll	scroll	scroll	scroll
scroll	scroll	scroll	scroll
User: John Doe			
SaveChg Ins Del			

#### Description:

This screen displays and maintains the work center/machine domain table. This table is a list of all the work center/dept numbers and machine numbers which are valid for the system, along with a short description of these machines. For measuring machines (CNC, CMM), it also lists the logical name corresponding to the directory where the measurement files are placed. Since work centers may contain more than one machine, the same work center may appear more than once in the list, one time for each individual machine.

To make changes to the existing table, the System Manager can simply type over what is already there. To add a new dept/work center to the table, the System Manager can scroll to a blank line and enter the information there.

After editing the table, the SaveChanges option must be selected from the menu line to make the changes permanent.

Fields:

1. Department/Work Center
2. Machine Id
3. Default Directory
4. Description

Menu Options:

1. SaveChg  
Save the changes made in this screen.
2. Ins  
Insert a new line.
3. Del  
Delete this machine.

#### 4.5.3 Field Names And Descriptions

This section describes all the fields used in the System Manager screens, and gives their type and length.

1. Menu\_Selection: integer, entry only

This is the only field on the display. The Menu\_Selection field specifies the user's choice from the menu. (Note that all the rest of the information which appears on the screen is static data which is part of the screen itself.)

Screens: System Manager Menu

2. User\_group\_displayed: 20 text display only  
This field indicates what subset of users are currently being displayed. Possible values are:

- o All Users
- o Operators & Inspectors
- o Engineer/Supervisors
- o System Managers

Screens: Maintain Users

3. User\_name\_last: 20 text display/entry  
This field contains the user's last name.

Screens: Maintain Users, Maintain AQAS Passwords

4. User\_name\_first: 10 text display/entry  
This field contains the user's first name.

Screens: Maintain Users, Maintain AQAS Passwords

5. Badge #: 5 text display/entry  
This field is the user's Employee ID Badge number.  
  
Screens: Maintain Users, Maintain AQAS Passwords
6. User\_class: 19 text display/entry  
This field is the user's class. Entry can be either one of the characters described above, or the first 2 or more characters of the full class name. Display values are:  
  
  - o Operator
  - o Inspector
  - o Engineer/Supervisor
  - o System Manager  
Screens: Maintain Users, Maintain AQAS Passwords
7. New\_password: 8 text entry only noecho  
The user's new password. This field is not displayed to the System Manager while he is typing.  
  
Screens: Maintain AQAS Passwords
8. Ver\_password: 8 text entry only noecho  
The user's new password, verified. This field is not displayed to the System Manager while he is typing.  
  
Screens: Maintain AQAS Passwords
9. Application\_port: 7 text display/entry  
The name of the LAT application port. These are of the form LTAn where n is a number between 1 and 9999.  
  
Screens: Maintain System Configuration Table



10. Physical\_device: 10 text display/entry  
The name of the physical device attached to that port.  
  
Screens: Maintain System Configuration Table
11. Associatedterminal: 10 text display/entry  
The physical device name for the terminal associated with the gage.  
  
Screens: Maintain System Configuration Table
12. Department/Work Center: 6 text display/entry  
The department and work center number.  
  
Screens: Maintain Dept/Work Center and Machine Domain Table
13. Machine Id: 8 numeric display/entry  
The machine identification.  
  
Screens: Maintain Dept/Work Center and Machine Domain Table
14. Default Directory: 8 text display/entry  
The logical name corresponding to the default directory in which the files uploaded for that machine are placed. Used for measuring machines.  
  
Screens: Maintain Dept/Work Center and Machine Domain Table
15. Description: 30 text display/entry  
A brief description of the machine.  
  
Screens: Maintain Dept/Work Center and Machine Domain Table

## CHAPTER 5

### SYSTEM ARCHITECTURE

AQAS software will eventually operate on two separate systems, one in Toledo and one in Gainesville. In the interim, it will operate on a shared system environment in Toledo. No substantial problem is anticipated in migrating the system in Phase III to the two separate systems. This chapter addresses the immediate system arrangement.

It should be pointed out that the systems deployed in Phase III will require the ability to restore service to users within a few minutes of the time of an outage of the MicroVAX computer. Another requirement will be the ability to protect data from the time it is taken in from the plant floor until the time it is archived off the system. Such protection may be afforded by a secondary disk or by logging data on to tape. These requirements are not necessarily to be met in Phase II.

#### 5.1 HARDWARE CONFIGURATION

Figure 5-1 shows the Phase II system architecture.

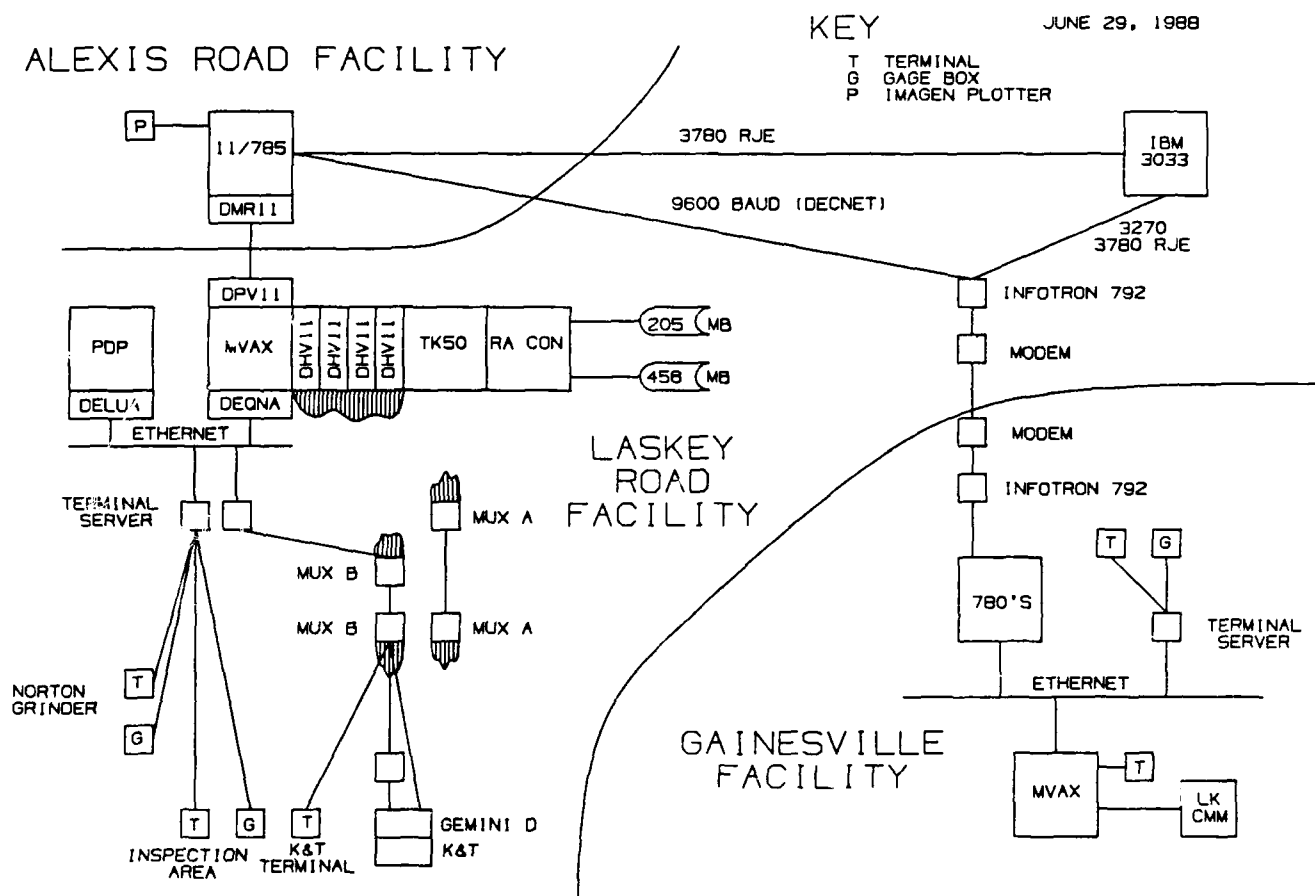


FIGURE 5-1 - PHASE II ARCHITECTURE

In the figure, T denotes terminals, TS terminal servers, G gages, P plotter, and M modems.

Ethernet in Gainesville covers a wide area in the plant, whereas in Toledo it will be limited to the computer room. Connections to the floor in Toledo will be made via RS-232 cables from terminal servers and ports in the computer room.

#### 5.1.1 Memory Capacity Requirements

Memory requirements are estimated for core and database as follows.

Core requirements are estimated at roughly 512 Kbytes per workstation. Additional core needed for basic operation does not significantly alter this estimate.

Database requirements are estimated by the following analysis.

##### Database Size Estimate

###### 1. Measurement Data

Approx. Record Size = 125 bytes

Volume = Number of Measurements per Year \* Record Size  
\* Life of Record

Initial Estimate =  $6,000,000 * 125 * 1 = 750,000,000$   
= 715.3+ Megabytes

###### 2. QOI Instruction Text

Approx. Record Size = 90 bytes

Volume = Number of Parts \* Ops/Part \* Characteristics/Op  
\* versions/characteristic \* Records/Version  
\* Bytes/Record

Initial Estimate =  $500 * 10 * 10 * 3 * 3 * 90 =$   
= 40,500,500+  
= 38.6+ Megabytes

###### 3. QOI Characteristic Data

Approx. Record Size = 90 bytes

Volume = Number of Parts \* Ops/Part \* Chars/Op  
\* Versions/Char \* Records/Version \* Record Size

Initial Estimate =  $500 * 10 * 10 * 3 * 1 * 90 =$   
= 13,500,000  
= 12.9 Megabytes

4. Serial Number List

Approx. Record Size = 60 bytes

Volume = Parts/Year \* Percent Serialized \* Years Running  
\* Records/Part \* Record Size

Initial Estimate =  $600,000 * 30\% * 10 * 1 * 60$   
= 108,000,000  
= 103 Megabytes after 10 years

5. Part-Lot-Operation-Char Data (QOI Used, etc.)

Initial Estimate = 1 Megabyte

Total Estimate

These top contributors to disk use take up a total space of some 870 Megabytes (data only). This amount may be thought of as a minimum bound on the size of the database.

There are a number of other potential contributors to disk space usage. These are

1. Additional tables to manage arbitrary creation of temporary numbers. - 5 to 50 megabytes.
2. Other database tables. - expected size 20 megabytes.
3. Ingres data table overhead. - proportional to raw data, but extent unknown.
4. Ingres internal tables. - extent unknown.
5. Ingres Forms and Query tables. - extent unknown.
6. Allowance of additional disk space to reduce disk fragmentation. - Roughly double space needed. (This is a rough rule of thumb that says if your database is more than 50% full, performance will suffer.)

With allowances for overhead and avoiding performance penalties, 2000 Megabytes is reasonable estimate of the needed space for this database.

The dominant feature of this database is the measurement data, which accounts for roughly 82% of the known raw data. For an effort to reduce the necessary database size to be effective, it must include a reduction in

- the amount of data kept on each sample
- the number of samples taken
- or, the amount of time each sample is kept before archiving.

While such a reduction is not necessary in the demonstration stage of AQAS, it might be considered before implementing a full scale system.

#### 5.1.2 Archiving

Archiving will be done using DCL command files and INGRES tools. The database should be backed up by the System Manager regularly, perhaps when normal system backups are done.

A command procedure will write the data from the relations to be archived to files, one file per relation. These files will then be backed up to tape. Each tape will contain one database backup.

To restore a backup to look at the data, a second database will be created. Another command file will be run to create that database, retrieve the data from the selected tape, then read the data from the backup files into the duplicate database. The user can then use INGRES tools to produce displays and reports to view the data. The data restored from an archive tape cannot be used by AQAS. This would produce inconsistencies in the data and corrupt the AQAS data base. It is possible, however, to retain certain data in the AQAS data base for as long as it is needed (beyond the one year point at which it would normally be archived off the data base).

The determination of which relations will be archived will be made during the construction phase.

#### 5.1.3 Connection Between Georgia And Toledo

This connection will use the existing multiplexed telephone line network between Toledo and Gainesville.

#### 5.1.4 Connection With Other Computer Systems

The AQAS computer communication with Plant computers, DNC computers, and CMM computers will be via DECnet Ethernet.

Connection with machining centers will be implemented via the DNC system in each plant. The Phase II system will share a computer with the Toledo DNC system, and will communicate internally. In Phase III, the primary computer will communicate with DNC. The Toledo backup AQAS computer would be the DNC computer itself, with internal communication between DNC and AQAS.

#### 5.1.5 Bar Code Readers

Bar codes will be used to identify both the QOI revision and the Employee Badge Number.

Each terminal will be equipped with a bar code wand and decoder. The wands will be capable of reading both high and medium resolution bar codes, enabling them to read both the badges (high) and the QOI (medium). The decoder box will be attached between the terminal and the terminal server, via the RS-232 line. Any code scanned by the wand is decoded and echoed to the screen. AQAS then treats the code the same as keyboard input.

Although the final selection of the bar code equipment has not yet been made, it is likely that the manufacturer will be either Welch-Allyn or Intermec.

#### 5.1.6 Terminal Types

Work station terminals will be DEC VT 330 and 340 color graphic terminals. DEC VT 220 terminals may be used for all non-graphic display screens.

### 5.2 SOFTWARE ARCHITECTURE

This section covers the following areas:

- AQAS Software Environment
- Standards and Procedures

#### 5.2.1 AQAS Environment

The AQAS software environment is composed of software systems from DEC, other third party software packages, and procedures developed by ITP for the AQAS system. The operating system is DEC VMS with all code to be developed in

Fortran. The data base is the INGRES relational data base from RTI (Relational Technology, INC.). User interface packages to be used include INGRES's forms development package (VIFRED), as well as Creative Software's DI-3000 Graphics package for development of graphics software.

To support development, DEC's CMS (Code Management System) and DEC'S MMS (Memory Management System) will be used. In addition, a layer of procedures developed by ITP will be used to record changes to the software in a program log so that the MMS procedure can be run nightly.

#### 5.2.1.1 Using INGRES Tools

INGRES tools can be used to view database information, cleanup database problems, and produce flexible reports.

There will be two main types of AQAS users who will have to use INGRES tools: those who are familiar with both INGRES and the internal architecture of the AQAS database, and those who are not familiar with either, but want to produce many different types of reports. A Quality Supervisor/Engineer might be interested in producing measurement or non-conformance reports for a wide variety of parameters. He should not need to know how the AQAS database is structured, or how to get around in INGRES, or what the various tools are. All he wants to be able to do is produce reports. The AQAS System Manager might need to clean up a corrupt database table, or replace missing data, or just look at a table to verify the integrity of the data. INGRES tools can therefore be classified into two groups: Reporting Tools and Data Maintenance and Review Tools, both of which use a data entity called a view.

5.2.1.1.1 Views - The AQAS database is composed of data in tables. Each table stores information about a certain data entity (see chapter 8 for a full description of the database). In order to retrieve all the information needed for a specific report, data must often be obtained from several tables, subject to a certain condition (give me all the information about parts with the same lot number, for example). This configuration of data can be saved so that the report can be produced again and again. The configuration produced this way is known as a "View", because it is a way to view information. The format of the report, what data are contained in it, what columns they are reported under, what headers are used, etc, are stored in an INGRES Report. INGRES provides a Report Writer facility to produce as many different types of report formats as are necessary. When a report format is used in conjunction with a view, the data is presented in the desired manner.



Initially, ITP will create a number of views which will be defined during the construction phase. Along with these views, ITP will create a number of standard reports. The user can interactively select a report format and view to produce a report. It is anticipated that number of ways to view the data will grow, and the AQAS System Manager will be able to create more views using SQL and more report formats using Report Writer.

It is also possible to view the data in a view or table by interactively specifying parameters (page length, column spacing, etc.) and ranges or data values when that report is produced. INGRES provides the Report-by-Forms facility for doing this.

Views can be produced using the INGRES SQL facility. An initial group of views will be defined by ITP, but additional views can be created later through the SQL facility and can be used by Query-by-Forms or Report-by-Forms.

5.2.1.1.2 INGRES Data Maintenance And Review Tools - These INGRES tools will be used by AQAS System Managers to view and maintain the database.

SQL (Standard Query Language) is an interactive database tool which allows the user to view and manipulate the data in the database. The user must have some general knowledge of the structure of the database, and then can use the SQL tools to look at the information in a table or view, or add or modify information in a table.

AQAS System Managers can also use SQL to create new views to be used in conjunction with Report-by-Forms or standard reports. Report Writer is another INGRES tool which can be used by AQAS System Managers to create standard reports. In this way new types of reports can be created.

SQL is a very powerful utility which allows the user to actually go in and change data in the AQAS database. It is therefore recommended that only AQAS System Managers who are familiar both with the workings of INGRES and the structure of the database use SQL. The views and reports they produce using SQL and the Report Writer can then be used by other users.

5.2.1.1.3 Producing Reports Using INGRES -

Quality Supervisor/Engineers, Operators and Inspectors can use INGRES tools to produce reports of all kinds for a variety of parameters. There are two ways in which this can be done: through the interactive report generator Report-by-Forms, or by using a standard report format previously constructed with the Report Writer.

The Report-by-Forms facility is simple and easy to use. The user specifies which table or view he would like to use, and then is prompted for simple formatting options (page length, column spacing, etc.). He can then specify ranges or values for any data items in the table or view. For example if he were producing a part lot report, he might want to specify a part lot number. The report is then generated and can be printed.

If the same report is generated more than one or two times, the user may wish to standardize it. Standard report formats can be stored using the Report Writer (see section above). Several standard reports will be available initially, and more can be created as the need arises.

When producing reports either using a standard format, or using the Report-by-Forms facility, data can only be viewed, not changed. Thus there is no danger that a user who is only slightly familiar but not completely comfortable with INGRES can corrupt the database accidentally.

#### 5.2.1.1.4 INGRES Accounts -

In order to have access to INGRES tools, a user must have an INGRES account. The System Manager will control these accounts and the privileges associated with them. Accounts are based on the user's VMS login id. Since each INGRES user must have his own account, the system manager can insure that unauthorized applications or users operating on the same machine with AQAS cannot access the AQAS database. Also, since accounts are issued for a specific database, several applications can be using INGRES at the same time, each with its own database, and the account system will insure that no application can access another's database, unless specific permission is given by the System Manager (by giving the user more than one account).

The INGRES facility used to maintain accounts is called "ACCESSDB". Only the System Manager can use ACCESSDB, as it can only be run from the special INGRES account that only the System Manager has access to.

#### 5.2.1.2 Assigning And Using Ethernet Ports With LAT

AQAS will use the VMS LAT (local area transport) protocol to retrieve gage information from the Ethernet ports which the gage port devices are attached to. The LAT software is part of VMS version 4.6 or later. LAT is used to connect ethernet ports in a LAT network. Although LAT does not use DECNET directly, it operates under DECNET through Ethernet, and can therefore be used to access ports on remote nodes.

The LAT software associates an application port with a physical ethernet port. That application port is a logical name which an application program (AQAS) can use to access the device connected to that port. Application port names are of the form "LTAn" where n is a number between 1 and 9999. Application programs cannot directly create application ports, this can only be done at the DCL level. At system start-up time, a command file will be run, creating application ports for all the physical ethernet ports. This is already done in Gainesville. AQAS maintains a mapping of application port names to physical devices (see AQAS System Manager User Interface, chapter 4, for details). Therefore it is very important that changes to the system start-up command procedure be kept in synch with the port configuration table.

AQAS can then use the LAT Port Driver QIO Interface to connect to and disconnect from the application ports which are allocated to the gage port devices. In this way the hand held gage results are read into the MicroVAX.

### 5.2.2 Standards And Procedures

The standards and procedures for the AQAS project are in the process of being defined, and will be completed during the next phase of the project. These standards and procedures will be incorporated into the System Manual upon completion of the Construction Phase of the project.

Developing a software system such as AQAS requires that a set of procedures be defined to handle both the development of the system and the operation of the system once it is in production. These procedures will serve as a means of standardization so that support of the system is fairly straight forward.

The development standards and the procedures will cover the following areas:

- o Screen Templates will be defined
- o Programming Standards and Procedures

Programming standards include defining templates for functions and include files, as well as basic standards for developing modular software.

- o Data Base Standards and Procedures

Data base standards will include those procedures which should be followed when using the data base.

o System Startup / Shutdown Procedures

The following are preliminary templates for a FORTRAN function and include file. These may be modified during the construction phase, if necessary.

```

*****
*
*      OPTIONS /NOCHECK
*      SUBROUTINE Q_SING
*      IMPLICIT NONE
**      DECLARE
*
*
*
*****
*
*N          Name: / Q_STEMP /
*T          Title: / Q_STEMP - Subroutine Template /
*
* ----- Revision History -----
*
*   Number:      Date:      By:      Description Of Change:
*       1         09/28/87    MRM       CREATE
*>
*H-----/ Functional Description /-----
*
* This routine is a template for all AQAS subroutines.
*
* Calling format:
*   Q_STEMP
*
*H-----/ Global AQAS Parameters /-----
*+
**INCLUDE INLINE 'TEL$SRC:Q_KGBL.QI'
*
*H-----/ Input Arguments /-----
*
*   Input parameters to the subroutine are listed and described here.
*
*H-----/ Output Arguments /-----
*
*   Output parameters from the subroutine are listed and described here.
*
*-----/ Data Base Activity /-----
*
*   All database tables used, and how they are invoked (READ_ONLY, UPDATE,
*   CREATE) is described here.
*<
*-----/ Modules Invoked /-----
*
*   Other modules called from this one are listed here.
*
*-----/ Common Areas /-----
** INCLUDE INLINE 'TEL$SRC:Q_EPARAM.QI'

```

```

* *****
*
* LOCAL VARIABLE DEFINITIONS:
*
* ----- Local Parameters -----
*
*          CHARACTER*12    C_PGMNAME
**          PARAMETER      (C_PGMNAME = "Q_STEMP ")
*
* ----- Declarations -----
*
** include inline "tel$src:q_lvars.qi"
**          CHARACTER*12    C_BUFFER
*
* ----- Data Statements -----
*
*
* *****
*          Pseudo Code
* *****
*
* *****
*          Subroutine Code
* *****
*
**include inline "tel$src:q_csin:t.qi"
*
*
* *****
*          Termination Code
* *****
** include inline "tel$src:q_csterm.qi"
9999    RETURN
        END

```

```
*****
*
*N          Name: / Q_ITEMP /
*T          Title: / Q_ITEMP - Include Template /
*
* ----- Revision History -----
*
*   Number:      Date:      By:      Description Of Change:
*       1         1/28/88    LMS       Created
*>
* ----- Description -----
*
*   This file is a template for include (common) files in the AQAS
*   System.
*
*<
***** Declarations *****
***** Common Areas *****

COMMON / COMMON_NAME /
1      COMMON_NAME_VAR1,
2      COMMON_NAME_VAR2,
3      COMMON_NAME_VAR3,
4      COMMON_NAME_VAR4

***** End of Q_ITEMP *****
```

## CHAPTER 6

### AQAS MEASUREMENT DEVICES

Several external devices are linked to the AQAS system through hardware and driver software, based on their individual characteristics.

#### 6.1 PROBE DEVICES

##### 6.1.1 Kearney & Trecker Machining Center

In Phase II, probe data files will be created in a Toledo K&T machining center under control of part programs using the K&T APL language facilities. AQAS will incorporate one machine in Phase II, while in Phase III there will be as many as 18 or more machining centers per site, not all of which will be K&T's.

The Toledo K&T machine will be linked to a shared DNC/AQAS MicroVAX using the MDX Maestro software (figure 6-1). The exact method of passing a probe file from the K&T to the MicroVAX will depend on the Maestro software options available. At a minimum, the DNC software supports upload of modified part programs. This is one possible communication route that will be explored outside of AQAS. Once the file is on the DNC microVAX and the user informs the AQAS that the file exists, the AQAS will take responsibility for the file and the probing data that it contains.



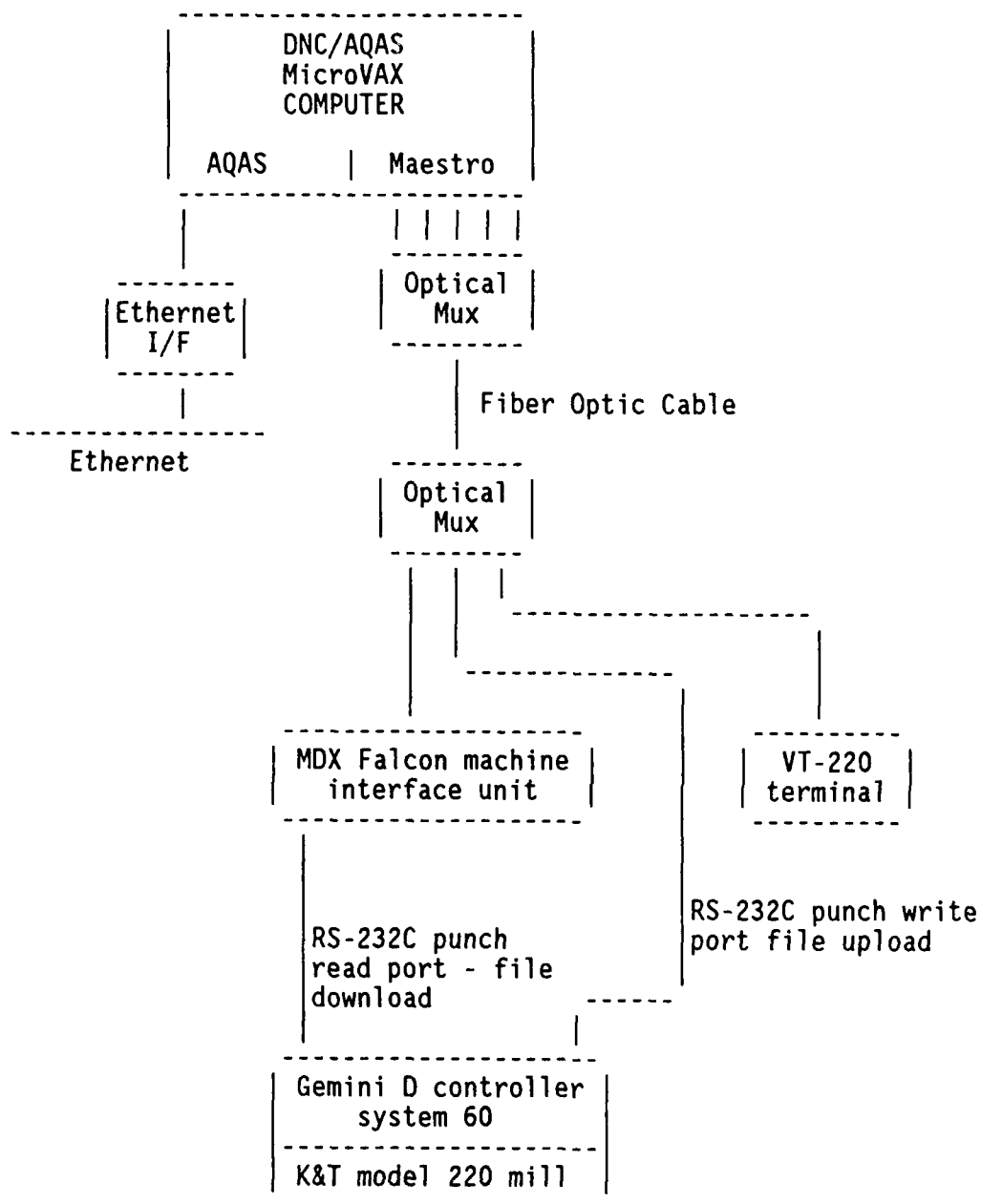


FIGURE 6-1 - DNC CONFIGURATION

#### 6.1.1.1 Collection Of K&T Inspection Results

This section describes the method by which the data is stored in the AQAS database.

The operator creates the probe file and uploads it to the MicroVax using the Maestro software (figure 6-2). It will be loaded into a specified directory and given a specified logical name.

The operator then goes to the AQAS "Data Collect Screen". He does this through the Operator Inspector Interface (see chapter 4 for details). At this point he has specified all the identifying information for the part he has measured with the K&T machine. He selects "READDATA", and then "FILE" from the menu line, in order to read measurement data into the screen from the file.

AQAS then goes and gets the file. If the file is not there, a message is displayed to the operator indicating that the file was not found. If it was found, AQAS will check to be sure that the Part Number, Serial Number, Lot Number and Operation number listed in the file are the same as the operator has specified in the screen. If they are not, then again, an error message is displayed to the operator. He may then wish to respecify his parameters and try again.

If the file is found, and the data matches, that data is then displayed to the operator, along with a datestamp indicating when the probe data was obtained. The operator can then treat this data the same as gage data; that is; he may edit, reject, or lock the results. If the operator chooses to lock the results, the data is read into the AQAS data base. When the operator leaves the screen, the probe file is deleted (whether or not he has locked the data). Thus if the operator leaves the screen without locking the results, he is indicating that he has rejected the probe measurements and will be so warned.

#### 6.1.1.2 K&T Probe File Format

The K&T Probe file should contain enough part identifying information to verify that the measurements are being stored for the correct part. AQAS can then read in the characteristic data for each characteristic code.

The following format is suggested:

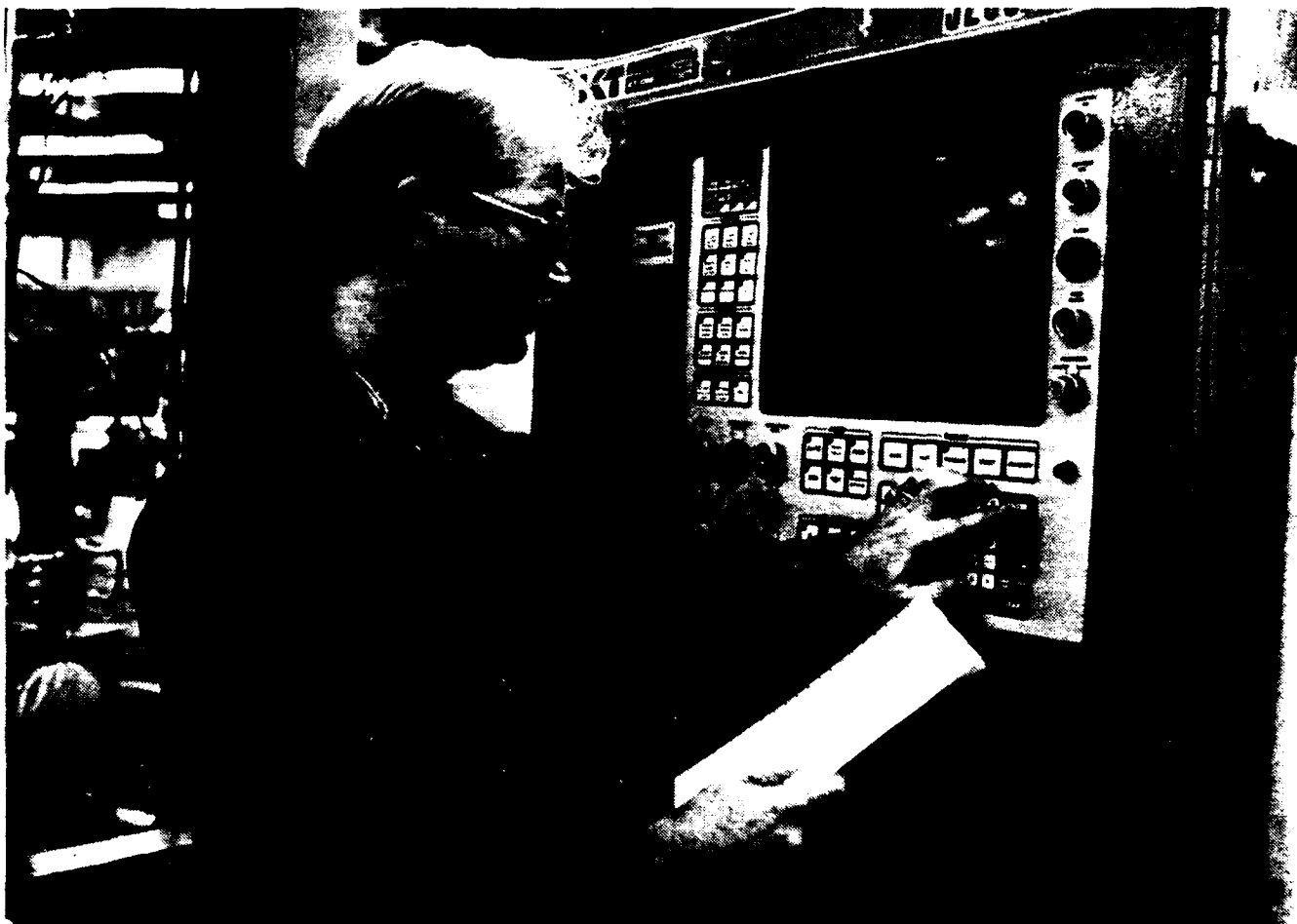


FIGURE 6-2 - UPLOADING PROBE FILE

- First line with date/time of file processing. The format for the date and time are: `yyyymmdd hhmmss`
- Part number on line beginning with the identifier: `AQ/PN` followed by the part number. This line is required.
- Lot Number after Part Number on line beginning with identifier: `AQ/LN` Followed by the Lot Number. This line is required.
- Part serial number after lot number beginning with the identifier: `AQ/SN` followed by the part serial number. This line is optional.
- Operation number after serial number beginning with the identifier: `AQ/ON` followed by the part operation number. This line is optional.
- Inspector number line that can be entered at file beginning, or between character codes beginning with the identifier: `AQ/IN` followed by the inspector's identification number. This line is required, but can be placed once at the beginning as a header or placed between the character code groupings.
- Groupings of information about each character code. This grouping can optionally contain the `AQ/IN` line (see above) if the inspector number changes. The grouping must begin with the identifier: `AQ/CC` followed by the character code. This line is required.

The K&T probe measurements for the identified characteristic follows the "AQ/CC" line.

#### 6.1.2 L-K Coordinate Measuring Machine

The Phase II demonstration of CMM compatibility will use an L-K CMM located in Gainesville, along with a data link between Toledo and Gainesville.

Data taken by the L-K CMM in Gainesville is presently output to a printer by the MicroVAX II computer.

Communication to the MicroVAX computer on the LK will be through Ethernet/DECnet. This link already exists between the clustered 780's and the LK MicroVAX. In addition, there is a DECnet link between the 785 in Toledo and the clustered 780's. Finally, a DECnet link will exist between the 785 and the AQAS/DNC MicroVAX. The communication path for files from the LK CMM is shown in Figure 6-3.

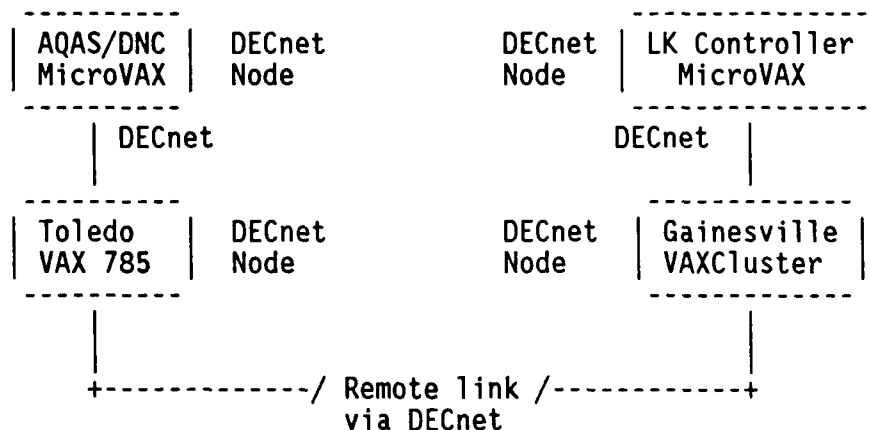


FIGURE 6-3 - COMMUNICATION BETWEEN AQAS MICROVAX AND LK MICROVAX

#### 6.1.2.1 Collection Of LK Inspection Results

The LK CMM controller is a MicroVAX based system communicating over DECnet with the AQAS computer (figure 6-4). The physical CMM is run by an LK inspection program using an inputted "inspection part program" written by a CMM inspection part programmer.

The operator must then use the AQAS LK CMM Post Processor to read the output file from the CMM inspection and writes a file which is readable by AQAS. The format of the AQAS-readable file is described in section 6.1.2.2 LK Inspection Data File Format. The format of the input file for the CMM Post Processor is described below:

##### 6.1.2.1.1 CMM Post Processor Input File Format -

Commands to the Post Processor are identified by the letters "AQ" on a line. Once the AQ is encountered, the rest of the line is ignored. The next line immediately after the AQ contains the data type, a two letter code, followed by a space, followed by the value of the data being read. The first "AQ" in the file must be followed by the date, on the next line. The next group of data make up the "header information" about a group of measurements. They are



FIGURE 6-4 - LK COORDINATE MEASURING MACHINE

"LN" - Lot number

"SN" - Serial number

"ON" - Operation number

"IN" - Inspector number

"PN" - Part Number

These can be placed in any order but there must be values for all before any measurement data can be read.

Measurement data can be taken for:

1. Diameters
2. True Positions
3. Both

Either a single value, or a number of values can be given. If a number of measurements are given for the same character code, the one which has the highest "difference" value (worst difference between nominal and actual) is reported.

Character codes are distinguished by the "CC" data type indicator. They can be one of the following:

CC 0001 (...)	: A single diameter
CC 0001 (T.P. ...)	: A single true position
CC 0001,0002 (T.P..)	: A diameter and true position

If the post processor encounters two consecutive occurrences of the same character code, it will continue to take results for that character code, until a different one is reached. It will then take the worst value for that character code, based on the difference field. Thus if the CMM output included 20 readings for character code 0001 (20 places), the one with the highest difference (between actual and nominal) would be transferred to AQAS. Immediately following the CC line (no lines between) the result block begins. This must be of the form:

	ACTUAL	NOMINAL	DIFFERENCE	HI-TOL	LO-TOL	MMC	ERROR
DIAMETER	0.1234	0.1240	-0.0006	0.1000	-0.1000		
T.P. RADIUS			0.0123	0.1000	-0.1000	0.0001	
T.P. ANGLE			321.1234				

These blocks contain the data for a single character code, or a pair (diameter and true position).

A result block must be preceded by a "CC" header line.

In general, comment lines and blank lines can be included in the file and will be ignored. The exceptions to this are:

1. An AQ line must be immediately followed by the data type code and data to be read.
2. A CC line must be immediately followed by the result blocks which make it up.

#### 6.1.2.2 LK Inspection Data File Format

- First line with date/time of file processing. The format for the date and time are: `yyyymmdd hhmmss`
- Optional readable comment information. Ignored by AQAS.
- Part number on line beginning with the identifier: `AQ/PN` followed by the part number. This line is required.
- Lot Number after Part Number on line beginning with identifier: `AQ/LN` followed by the Lot Number. This line is required.
- Part serial number after lot number beginning with the identifier: `AQ/SN` followed by the part serial number. This line is optional.



- Operation number after serial number beginning with the identifier: AQ/ON followed by the part operation number. This line is optional.
- Inspector number line that can be entered at file beginning, or between character codes beginning with the identifier: AQ/IN followed by the inspector's identification number. This line is required, but can be placed once at the beginning as a header or placed between the character code groupings.
- Groupings of information about each character code. This grouping can optionally contain the AQ/IN line (see above) if the inspector number changes. The grouping must begin with the identifier: AQ/CC followed by the character code. This line is required.

The LK formatted inspection data for the identified characteristic follows the "AQ/CC" line.

## 6.2 GRINDER CONTROL GAGES

The AQAS demonstration phase incorporates one grinder control gage - a Marposs E39 "self-mastering" gage. Measurements are taken directly from this gage and read into AQAS.

There are three "cycles" under which the E39 can operate:

1. In-process cycle, where the gage measures a part during the grinding cycle (figure 6-5). The in-process cycle sends control signals to the grinder controller to control grind speed and dwell time.
2. Post-process cycle, where the gage measures a part after grinding is finished. This is the usual way to take a measurement for AQAS, and is the focus of the rest of this section.
3. Self-Mastering cycle, where a reference diameter master element is fixtured next to the part in process, possibly within the coolant stream. The gage head can be retracted periodically to recalibrate the amplifier on the master.

The Marposs E39 reports its measurements in analog format. The analog signal is read in during the post process cycle. It is converted to an integer value by the Observational Systems Gage Port device.



FIGURE 6-5 - IN-PROCESS GAGES

The operator signals the Gage Port device to read the value from the grinder gage by pressing a footswitch. The Gage Port converts the analog signal to an integer in the range 0 to 2048 with zero volts equal to a value of 1025. This integer is, in turn, converted to a real dimension based on a previously calculated conversion factor entered into AQAS by the user.

The sequence of steps required to measure a part is:

- Initialize AQAS and the gage port device (done only once per AQAS session).
- Master the E39 on a known dimension using master mounted on the grinder (done infrequently - interval will be based on E39 experience).
- Setup the grinder gage for the characteristics to be measured by this gage. This includes entry of the scale factor for the E39 (the scale factor is on a tag on the front of the E39 and is entered only once for a given inspection lot).
- Enter the data collection screen and position the cursor on the character code that is being ground. Enter the master value from step two as the offset on the data collection screen.
- Grind the part using the in-process cycle.
- After the grind, switch the E39 to post-process cycle and jump the gage onto the part.
- Jog the part rotation button a few times to seat the gage and simultaneously, check for runout on the E39 display. Set the gaging location at a low or high spot, if appropriate (figure 6-6).
- Select the read gage option on the data collection display and press the footswitch. This can be done as many times as desired, and the part can be jogged between readings as needed. AQAS displays the value and checks the result against tolerance.
- Lock AQAS data when satisfied that the result is correct.
- Return the E39 to in-process cycle.
- Go on to the next grind on the part, and position the AQAS cursor on the next character code. Otherwise, go to the next part.

Precision of Measurement Values



FIGURE 6-6 - POST PROCESS CYCLE

The E39 gage display resolution is 50 millionths of an inch. This is more precise than the 100 millionths shown to the AQAS user. The Gage port device can resolve dimensions to better than 15 millionths as installed. Because quality results are not reported to less than 100 millionths, AQAS resolves the inconsistency by setting the screen display to agree with the rounded Marposs E39 display value.

In practice, the Marposs E39 display out-of-tolerance display (red LED's on the E39) as well as the digital display agree with the AQAS oversize/undersize display flag and AQAS result shown to the user.

In addition to the self-mastering gage, the AQAS demonstration included the acquisition of data from a Marposs E-4 column gage located at a Norton grinder workstation in Toledo (see section on Analog Gages, below).

### 6.3 HAND-HELD GAGES

#### 6.3.1 Digital Gages - Mitutoyo

The Phase II system will demonstrate the use of several Mitutoyo hand-held gages as examples of the great variety of such gages that will eventually be used in Phase III. To accommodate the variety of possible brands of gages, GagePort units will be used (figure 6-7).

A single GagePort can interface to two different gages, and up to 16 GagePorts can be linked together with a single RS-232 interface; providing for up to 32 gages at a workstation. These boxes convert the signal from a digital hand-held gage to serial RS-232 communication at 300, 1200, or 9600 baud for direct entry into a computer system. Each port can be uniquely cabled for a different brand of gage, so that the final AQAS product will not be limited to the initial test group, Mitutoyo gages.

The gage port RS-232 outputs will be attached directly to ethernet terminal server ports and/or computer ports. The system manager's interface maintains a relationship between a physical terminal port and a physical port near the terminal that is wired for use with gages.

Because the gage port is a device incapable of logging itself onto the system (a "dumb" device), DEC operating system (VMS) system services are used to attach an application to a line. Thereafter, that port is owned by the application and will not be freed until the user of the terminal finishes the AQAS session.

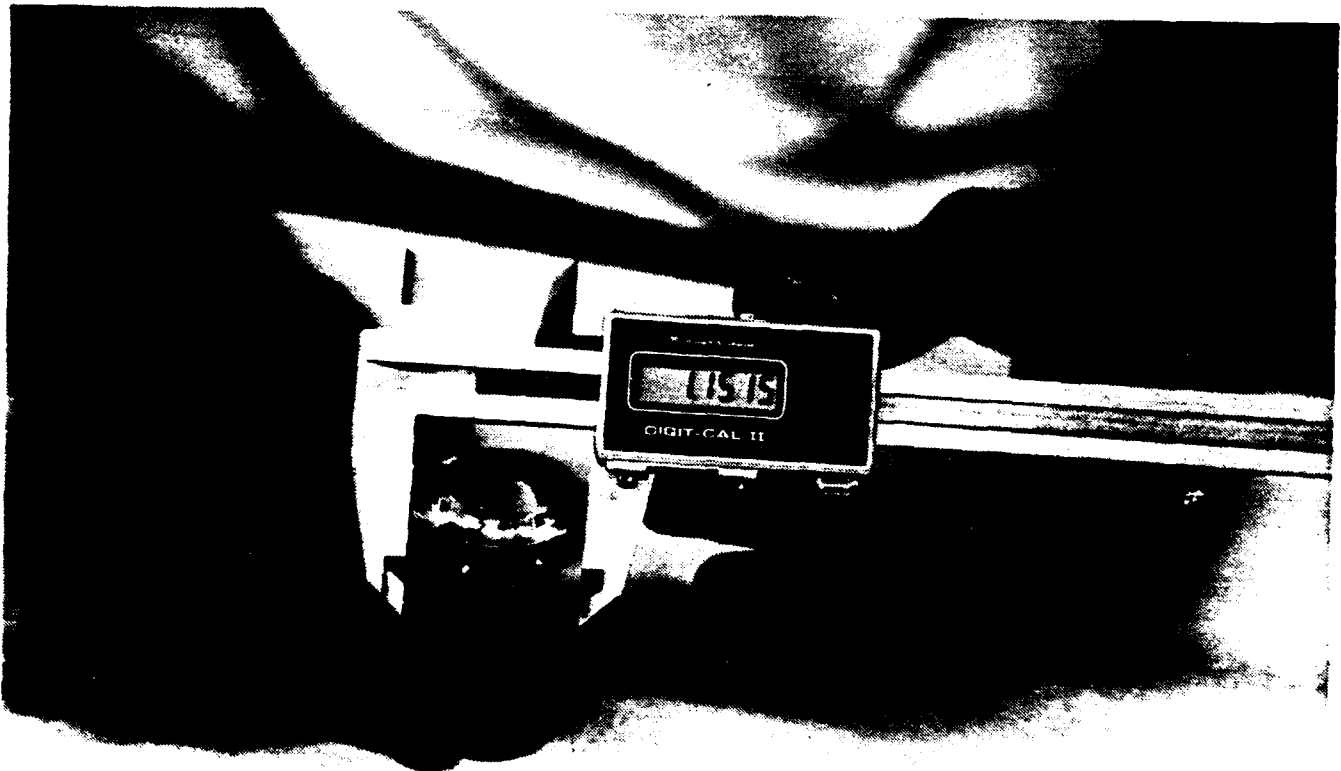


FIGURE 6-7 - DIGITAL GAGE

A footswitch attached to the gage port signals AQAS to read the gage. This allows freedom of both hands to hold and measure a part. Prior to pressing the footswitch, the user must tell AQAS to expect an automatically gaged measurement by selecting the ReadGage option.

### 6.3.2 Analog Gages

Analog gages will be interfaced through another model of the GagePort. The signal arriving from an analog gage is a voltage reading. The gage port converts the voltage to digital RS232, which is then transmitted to the host computer.

When received by the host, the signal is a digitized voltage reading, not a true measurement value. The digital reading is converted to measurement units by a multiplier based on mV/in (usually a power of 10: 1, 10, ...). This multiplier is, in the case of the Marposs E4 column gage (figure 6-8), read from a calibration sticker near a rotary switch on the front of the gage and input prior to taking the measurement. The calibration value for the Marposs E4 using a standard gage port cable is calculated by:

$(\text{rotary switch position [in inch]}) / (339).$

In some cases, there is also a need to offset the measurement reading. This occurs where the zero voltage reading does not correspond to a measurement value of zero (the general case for the column gage). This offset is inputted on the data collection screen, because the column gage can be zeroed out on a different master for different character codes.

Analog gages other than the Marposs E4, are be handled in the same way as outlined above.



FIGURE 6-8 - ANALOG GAGE



## CHAPTER 7

### EXTERNAL SYSTEM INTERFACES

This chapter discusses the system interfaces with the Plant Computer System. It includes a general discussion, a more in depth look at the contents and organization of data transfer records, and a look at scenarios for common data updating tasks.

#### 7.1 GENERAL DISCUSSION

AQAS expects to receive one data file per day. The loading of this data file into the AQAS database is initiated in one of two ways:

- automatically once per day.
- by request through the Quality Supervisor/Engineer Interface

The scheduling system will create and download this file into the AQAS computer. Once per day, AQAS will load a new file if it has received one. If a file is loaded some other time of day, the "by request" option can be used.

First-time loading of data into the AQAS system will be accomplished using these same data files. The plant system will create the files as it would on any other run. The main difference would be the amount of data in the file, since initial versions of many records would have to be loaded, rather than simply updates.

#### 7.2 AUTOMATIC DAILY FILE DOWNLOAD

Once a day, a timed process will be triggered in AQAS to read a file downloaded from the Plant computer. The name of the file, including the directory specification will be a VMS logical, so that the directory/file can be changed at any time through VMS.

The AQAS download read process verifies the integrity of the file in two ways:

- AQAS checks the date stamp on the file and the date stamp of the latest information in the database. If the date of the file is earlier than the one in the database, the file read is aborted, and an error message is logged.
- AQAS checks for an end-of-file specification, to be sure that the entire file was received. Again, if no marker is found, the read is aborted and an error message is logged.

Further verification can be done by the user when he views the data. If the data appears corrupt, the database can be cleaned up using INGRES SQL (see chapter 5 for a full discussion of INGRES tools), and a new file download can be initiated on the Plant computer. At that time a request to read the new information can be issued from the AQAS Quality Supervisor/Engineer User Interface.

While the data is being written into the AQAS database, it is locked so that other users cannot access it. This is done to insure that users do not get incorrect data because half of the database has been updated, and half has not. Since the file download will probably be scheduled for a time when AQAS is not being used heavily, and downloads will not consist of complete files, but only of updates, it is not anticipated that the database lock will hold up AQAS for an extended length of time.

While the download read job is running, it is probable that no users will be around to monitor its progress. For this reason status messages will be logged to an error log file. Users can check this file when they come in to verify that the download read completed without errors.

### 7.3 EXTERNAL DATA TRANSFER RECORDS

The following is a list of record layouts for data download to the AQAS. There are 14 record types. These record types are used to control the updating and deletion of information in the AQAS by other systems.

The record types are

1. File Header

Used to indicate a date/time of download.

2. Gage Calibration Update

Used to give a calibration date for a gage.

3. Gage Calibration Delete

Used to remove a gage from the calibration list.

4. Part Lot Work Order

Used to indicate a new part lot released for production.

5. QOI Operation Update

Used to create a new QOI Revision, or to make an existing QOI Revision refer to a different blueprint revision.

6. QOI Operation Delete

Used to remove all information about a QOI Revision from the list of valid revisions.

7. QOI Characteristic Data

Used to specify or modify data about how a specific characteristic is measured. This may be modified. It is not anticipated that this will be deleted without deleting the QOI Header as well. (Due to record length limitations, there are two QOI Characteristic Records.)

8. QOI Gage Update

Used to add a gage to the list of gages allowed for a measurement.

9. QOI Gage Delete

Used to delete the list of valid gages for a measurement.

10. QOI Instruction Header

Used to start a text instruction for taking a measurement.

11. QOI Instruction Text

Used to continue a text instruction for taking a measurement. This record type actually contains the instruction text.

12. QOI Instruction Trailer

Used to conclude a text instruction for taking a measurement.

13. QOI Instruction Delete

Used to delete the text instruction for a measurement. Only used if the instructions are not going to be replaced. Otherwise, use the above two record types.

14. QOI Revision Log Update

Used to add to the list of OSO Revisions that are valid for this QOI Revision.

15. QOI Revision Log Delete

Used to delete the list of OSO Revisions that are valid for this QOI revision.

### File Header Record

This record is first in the file. It contains information about all the records in the file.

- Record Type Code

Format: 3 characters.  
Value: "Q00"

- Date Stamp

Format: yyyymmdd  
Purpose: To indicate when the file was created.

- Time Stamp

Format: hhmmss  
Purpose: To indicate when the file was created.

This record is used to establish the "Change Date" for each record in the database as it is loaded or modified. If this record appears mid-file, it indicates that all following records have a new effective date.

### Gage Calibration Update Record

The record format of this file is as follows:

- Record Type Code

Format: 3 characters  
Value: "Q01"

- Gage Serial Number

Format: 20 characters  
Purpose: Identify an individual gage

- Gage Description

Format: 40 characters  
Purpose: Describe the gage type

- Calibration Due Date

Format: yyyymmdd

Purpose: To control at what date the validation of this gage expires.

#### Gage Calibration Delete Record

The record format of this file is as follows:

- Record Type Code

Format: 3 characters

Value: "Q02"

- Gage Serial Number

Format: 20 characters

Purpose: Identify an individual gage

#### Part Lot Work Order Record

The record format of this file is as follows:

- Record Type Code

Format: 3 characters

Value: "Q03"

- Lot Number

Format: 10 characters

Purpose: To identify a part lot. (Currently, only 4 characters are used.)

- Part Number

Format: 20 characters

Purpose: To identify the type of parts in a part lot

- Part Quantity

Format: 7 characters (numeric)

Purpose: To state the number of parts in the lot

- Part Description

Format: 40 characters

Purpose: To give a text description of the parts

### QOI Operation Record Update

The QOI Operation Record will contain the following information:

- Record Type Code

Format: 3 characters.

Value: "Q04"

- Part Number

Format: 20 characters.

Purpose: To identify a part number.

- Operation Number.

Format: 7 characters. (4 numeric, 3 alpha)

Purpose: To identify a type of operation on a part number.

- QOI Revision Number.

Format: 2 characters.

Purpose: Used internally in AQAS to control the list of valid QOI records.

- Work Center Number

Format: 6 characters.

Purpose: Display Only. This field has a different meaning in the Phase II (Toledo) and Phase III (Gainesville) systems. Phase II uses the first three digits to identify the department and the final three digits to identify the work station, or group of machines. Phase III uses the first two digits for cell and the final four for asset number.

- Blueprint Revision Number. (of Engineering Drawing Number)

Format: 2 characters.

Purpose: Display Only.

### QOI Operation Record Delete

The QOI Operation Record will contain the following information:

- Record Type Code  
Format: 3 characters.  
Value: "Q05"
- Part Number  
Format: 20 characters.  
Purpose: To identify a part number.
- Operation Number.  
Format: 7 characters. (4 numeric, 3 alpha)  
Purpose: To identify a type of operation on a part number.
- QOI Revision Number.  
Format: 2 characters.  
Purpose: Used internally in AQAS to control the list of valid QOI records.

### QOI Characteristic Data Record

The fields in the QOI Characteristic record include:

- Record Type Code  
Format: 3 characters.  
Value: "Q06"
- Part Number  
Format: 20 characters.  
Purpose: To identify a type of part.
- Operation Number.  
Format: 7 characters.  
Purpose: To identify an operation on a part number.



- QOI Revision Number.

Format: 2 characters.

Purpose: Used internally in AQAS to control the list of valid QOI records.

- Character Code

Format: 4 characters.

Purpose: To identify a particular characteristic to be measured.

- Appraisal Code

Format: 3 characters.

Purpose: Used internally in AQAS to control what parts are measured.

Two character field depicting (1st char) the type of control and (2nd char) the audit level applied.

- Maximum Dimension - real number

Format: 8 characters (999.9999)

Purpose: Used internally in AQAS.

- Minimum Dimension - real number

Format: 8 characters (includes a decimal point).

Purpose: Used internally in AQAS.

- Dimension Type

Format: 6 characters

Purpose: Used internally in AQAS. Specifies measurement type, e.g. Inner Diameter.

- Sheet

Format: 1 character.

Purpose: Display Only.

- Section

Format: 6 characters.

Purpose: Display Only.

- Zone

Format: 4 characters.

Purpose: Display Only.

- Verify or Record Indicator

Format: 1 character.

Purpose: Used Internally in AQAS.

#### QOI Characteristic Data Record (2)

The fields in the QOI Characteristic Record (2) include:

- Record Type Code

Format: 3 characters.

Value: "Q15"

- Part Number

Format: 20 characters.

Purpose: To identify a type of part.

- Operation Number.

Format: 7 characters.

Purpose: To identify an operation on a part number.

- QOI Revision Number.

Format: 2 characters.

Purpose: Used internally in AQAS to control the list of valid QOI records.

- Character Code

Format: 4 characters.

Purpose: To identify a particular characteristic to be measured.

- Controlling Character Code

Format: 4 characters.

Purpose: To identify a controlling characteristic to be measured.

- QOS Page

Format: 2 characters

Purpose: Page number of QOS sketch

- Sort Sequence

Format: 4 numeric

Purpose: a sorting sequence number if different from the characteristic codes.

#### QOI Gage Update Record

The fields in the QOI Gage Update record include:

- Record Type Code

Format: 3 characters.

Value: "Q07"

- Part Number

Format: 20 characters.

Purpose: To identify a type of part.

- Operation Number.

Format: 7 characters.

Purpose: To identify an operation on a part number.

- QOI Revision Number.

Format: 2 characters.

Purpose: Used internally in AQAS to control the list of valid QOI records.

- Character Code

Format: 4 characters.

Purpose: To identify a particular characteristic to be measured.

- Gage Count

Format: 1 character. (value range is 1-4)

Purpose: To identify the order in which gages should be selected. For instance, the gage identified with a gage count of "1" should be used in preference to gage number "2".

- Gage Number

Format: 20

Purpose: Display only

This field is display only to AQAS, since AQAS does not do any checking that the serialized gage is of the correct type.

#### QOI Gage Delete Record

The fields in the QOI Gage Delete record include:

- Record Type Code  
Format: 3 characters.  
Value: "Q08"
- Part Number  
Format: 20 characters.  
Purpose: To identify a type of part.
- Operation Number.  
Format: 7 characters.  
Purpose: To identify an operation on a part number.
- QOI Revision Number.  
Format: 2 characters.  
Purpose: Used internally in AQAS to control the list of valid QOI records.
- Character Code  
Format: 4 characters.  
Purpose: To identify a particular characteristic to be measured.

#### QOI Instruction Header Record

The fields in the QOI Instruction Header record include:

- Record Type Code  
Format: 3 characters.  
Value: "Q09"

- Part Number

Format: 20 characters.

Purpose: To identify a type of part.

- Operation Number.

Format: 7 characters.

Purpose: To identify an operation on a part number.

- QOI Revision Number.

Format: 2 characters.

Purpose: Used internally in AQAS to control the list of valid QOI records.

- Character Code

Format: 4 characters.

Purpose: To identify a particular characteristic to be measured.

- Characteristic Description

Format: 25 characters.

Purpose: A short description of special gage selection, settings, or other data. Typically used to describe thread gage measurements or other measurements which do not fit the Max/Min format.

#### QOI Instruction Text Record

The fields in the QOI Instruction Text record include:

- Record Type Code

Format: 3 characters.

Value: "Q10"

- Line Count

Format: 3 characters (numeric).

Purpose: To establish order for lines of text.

- Characteristic Instructions

Format: 50 characters.

Purpose: Display Only

### QOI Instruction Trailer Record

The fields in the QOI Instruction Trailer record include:

- Record Type Code  
Format: 3 characters.  
Value: "Q11"
- Part Number  
Format: 20 characters.  
Purpose: To identify a type of part.
- Operation Number.  
Format: 7 characters.  
Purpose: To identify an operation on a part number.
- QOI Revision Number.  
Format: 2 characters.  
Purpose: Used internally in AQAS to control the list of valid QOI records.
- Character Code  
Format: 4 characters.  
Purpose: To identify a particular characteristic to be measured.

### QOI Instruction Delete Record

The fields in the QOI Instruction Delete record include:

- Record Type Code  
Format: 3 characters.  
Value: "Q12"
- Part Number  
Format: 20 characters.  
Purpose: To identify a type of part.

- Operation Number.

Format: 7 characters.

Purpose: To identify an operation on a part number.

- QOI Revision Number.

Format: 2 characters.

Purpose: Used internally in AQAS to control the list of valid QOI records.

- Character Code

Format: 4 characters.

Purpose: To identify a particular characteristic to be measured.

### QOI Revision Log Update Record

The QOI Revision Update record is used to approve changes to the existing QOI plan for a new OSO revision.

The fields included in this record are:

- Record Type Code

Format: 3 characters

Value: "Q13"

- Part Number

Format: 20 characters

Purpose: To identify a part type.

- Operation Number

Format: 7 characters

Purpose: To identify a type of operation on a part number.

- QOI Revision Number

Format: 2 characters

Purpose: Used internally in AQAS.

- OSO Revision Number

Format: 4 characters

Purpose: Used internally in AQAS.

- Initials of who made the change.

Format: 3 characters.

Purpose: Display Only.

#### QOI Revision Log Delete Record

The QOI Revision Delete record is used to remove all entries from the list of valid OSO revisions for a specific QOI revision. Typically this would be followed by a new list of valid OSO revisions.

The fields included in this record are:

- Record Type Code

Format: 3 characters

Value: "Q14"

- Part Number

Format: 20 characters

Purpose: To identify a part type.

- Operation Number

Format: 7 characters

Purpose: To identify a type of operation on a part number.

- QOI Revision Number

Format: 2 characters

Purpose: Used internally in AQAS.



- OSO Revision Number

Format: 4 characters

Purpose: Used internally in AQAS.

#### 7.4 EXTERNAL DATA TRANSFER SCENARIOS

All data transfer files must start with a "Q00: File Header Record". If a "Q00" record occurs in the middle of a file, the effective date for all subsequent records in the file is updated.

This list does not give a complete set of rules for data transfer scenarios. Instead, it gives examples of anticipated scenarios.

The "trigger" entries for each scenario indicate why or when that scenario might be used. The "record sequence" outlines the order in which the records should appear in the file.

It is recommended that files not be ended in the middle of one of these scenarios. Splitting a scenario between two files may cause unexpected truncation of instructions, gage lists, or unexpected "change date" entries in the database.

##### 1. Adding a Gage to Calibration Control

Trigger: whenever a new gage is put under calibration control

Record Sequence:

- Q01: Gage Calibration Update

##### 2. Updating a Gage Calibration Date

Trigger: whenever a new calibration date is calculated.  
(typically after calibration is done)

Record Sequence:

- Q01: Gage Calibration Update

3. Deleting a Gage from Calibration Control

Trigger: whenever a gage is removed from calibration control.  
(typically after gage is removed from system)

Record Sequence:

- Q02: Gage Calibration Delete

4. Issuing a Part Lot

Trigger: whenever a parent lot is issued.  
(not done at split)

Record Sequence:

- Q03: Part Lot Work Order

5. Creating a New QOI Revision

Trigger: whenever a new QOI revision is created in QOI system.

Record Sequence:

- Q04: QOI Operation Update
- Q06: QOI Characteristic Data
- Q07: QOI Gage Update
- Q07: QOI Gage Update
- Q07: QOI Gage Update
- Q07: QOI Gage Update
- Q09: QOI Instruction Header
- Q10: QOI Instruction Text
- Q10: QOI Instruction Text
- Q10: QOI Instruction Text
- Q10: QOI Instruction Text
- Q11: QOI Instruction Trailer
- Q06: QOI Characteristic Data
- Q07: QOI Gage Update
- Q07: QOI Gage Update
- Q07: QOI Gage Update
- Q07: QOI Gage Update
- Q09: QOI Instruction Header
- Q10: QOI Instruction Text
- Q10: QOI Instruction Text
- Q10: QOI Instruction Text
- Q10: QOI Instruction Text
- Q11: QOI Instruction Trailer
- Q06: QOI Characteristic Data
- Q07: QOI Gage Update
- Q07: QOI Gage Update
- Q07: QOI Gage Update

- Q07: QOI Gage Update
- Q09: QOI Instruction Header
- Q10: QOI Instruction Text
- Q10: QOI Instruction Text
- Q10: QOI Instruction Text
- Q11: QOI Instruction Trailer
- Q13: QOI Revision Log Update

6. Modify Characteristic Data

Trigger: small changes to QOI characteristic data  
(without changing QOI revision number)

Record Sequence:

- Q06: QOI Characteristic Data

7. Update Gage List for a Characteristic

Trigger: small changes to QOI characteristic data  
(without changing QOI revision number)

Record Sequence:

- Q08: QOI Gage Delete
- Q07: QOI Gage Update
- Q07: QOI Gage Update
- Q07: QOI Gage Update
- Q07: QOI Gage Update

8. Update QOI Instruction Text

Trigger: small changes to QOI instruction text  
(without changing QOI revision number)

Record Sequence:

- Q09: QOI Instruction Header
- Q10: QOI Instruction Text
- Q10: QOI Instruction Text
- Q10: QOI Instruction Text
- Q11: QOI Instruction Trailer

9. Approve New OSO - QOI pair

Trigger: change to QOI Revision Log  
(in response to something other than a new QOI revision)

Record Sequence:

- Q13: QOI Revision Log Update

10. Delete All Gages for a Characteristic

Trigger: not anticipated  
Record Sequence:  
- Q08: QOI Gage Delete

11. Delete Instruction for a Characteristic

Trigger: not anticipated  
Record Sequence:  
- Q12: QOI Instruction Delete

12. Delete QOI Revision Log Entry

Trigger: to remove approval from a QOI-OSO pair  
Record Sequence:  
- Q14: QOI Revision Log Delete

13. Delete QOI Revision

Trigger: not anticipated  
Record Sequence:  
- Q05: QOI Operation Delete

## CHAPTER 8

### PRELIMINARY COST/BENEFIT

#### 8.1 PRELIMINARY COST ASSESSMENT

This chapter discusses results of a preliminary cost/benefit assessment of the AQAS project through its implementation. Currently, TCAE funding has been allocated to take an Ethernet computer network out to the factory floor and strategically place terminals for AQAS access in the Toledo facility. AQAS will contain inspection records for parts which run across numerous machines. By placing terminals at these machines, AQAS can be phased in for specific parts. After a limited use, plans for full scale implementation can be formulated based on experience gained and the appropriate hardware and software can be obtained for implementation in both Toledo and Gainesville facilities.

Based on this approach to implementation, cost has been estimated for procurement of required hardware and software along with in-house labor estimates. Based on these time phased expenditures and estimated benefits, a discounted cash flow model will be run for a follow on Phase III proposal

##### 8.1.1 Implementation Plans

The demonstration phase of the AQAS project was highly successful. The user community and management are anxious to begin implementation. Funding has been allocated to phase AQAS into the Toledo facility for 1989. Working out logistics and procedures on a limited basis in 1989 will prepare TCAE for a broader implementation.

With success in the limited application of this technology, procurement of adequate hardware and software is planned in 1990 for full scale implementation.

Figure 8.1 describes the tasks anticipated for implementation.

AQAS IMPLEMENTATION

PROGRAM MILESTONES	1989				1990				1991				1992			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
PHASE III PROPOSAL		0														
INITIAL HARDWARE PROCUREMENT		0														
TRAIN APPLICATION MANAGER		0														
DEVELOP TRANSITION PLAN		0														
FAULT TOLERANCE ANALYSIS		0														
PREPARE DISASTER RECOVERY PLAN		0														
PREPARE STANDARD OPERATING PROCEDURES		0	==	0												
LOAD AQAS DATABASE		0														
DEVELOP TRAINING MANUALS			0													
TRAIN QUALITY ENGINEERS/SUPERVISORS			0=	0												
TRAIN OPERATORS/INSPECTORS			0=	0												
PHASE IN LIMITED NUMBER OF PARTS			0==	0												
PROCURE ADDITIONAL HARDWARE & SOFTWARE					0											
PHASE IN PRODUCTION PARTS					0=====	0										

FIGURE 8-1 - AQAS IMPLEMENTATION

### 8.1.2 Material Requirements

Material requirements for a limited 1989 implementation consist mainly of additional disk (622 Mb disk sub-system), terminal servers, terminals and installation of Ethernet on the factory floor. Additional CPU, disk, terminal servers, terminals, software licenses, etc. will be required for a broader implementation in the 1990 - 1991 time frame.

### 8.1.3 Manpower Requirements

An application manager will be required to oversee implementation and further support. The application manager will coordinate development of a transition plan, disaster recovery plan, training manuals, and standard operating procedures. Operators, inspectors, supervisors and quality engineers will be trained on AQAS. After implementation, support will be available for extensions or modifications and general maintenance of the AQAS software. (Some possibilities for extensions or modifications are described in Chapter 10).

## 8.2 PRELIMINARY BENEFIT ASSESSMENT

When implemented in full production, benefits achieved through use of AQAS include:

- Reduction of paper master files and their maintenance.
- Ease of implementing quality operation instruction changes.
- Reduction in data analysis time.
- Reduction in time for monitoring procedures. Many controls will be enforced by AQAS.
- Through added visibility into the process, process control can be improved.
- Quality planning on new designs will be immediately transferable to TCAE Gainesville division.

Manpower reductions are estimated at 25% in the quality engineering function and 25% in the inspection function. AQAS will also reduce scrap and rework cost by at least 20%.

## CHAPTER 9

### INSTALLATION TECHNICAL RECOMMENDATIONS

This chapter presents a list of technical recommendations for TCAE's factory-wide installation of AQAS. In some cases, features added for AQAS will be useful for other systems, spreading the costs and the benefits.

These recommendations are not part of Phase II but will be reviewed as part of the Phase III implementation plan. These recommendations will require cost/benefit analysis and assessment of technical fit with TCAE's computer environment.

Other chapters document long-term integration suggestions or human system concerns - this chapter is solely devoted to technical changes or enhancements based on experience or current limitations.

Cost versus benefit is not a factor in this chapter. A separate determination of this cost versus benefits is needed.

#### 9.1 UPGRADE DECNET CONFIGURATION

The current DECnet installation requires an account on each and every computer system. Further, to insulate shop floor workers from the network configuration, AQAS introduces several logicals. These logicals must have accounts and passwords embedded in them - a potential security problem.

DECnet can be configured with DECnet default accounts that allow a user to move "through" a node without having to "stop" (and login) at each point. Passwords are only needed at the endpoints, actually adding to security.

Where a particular node requires very tight security, DECnet provides several options (see DEC's network documentation).

#### 9.2 EXTEND ETHERNET TO THE FACTORY FLOOR

ITP's experiences with ethernet run through a factory are very good. Based on this experience, we recommend extending the Toledo cabling to the factory floor.



This is less expensive and more flexible than running RS-232 lines to every terminal and every gage port. We noted that Toledo already has two ethernet networks - one for the PMACS project and one for DNC/AQAS. These two networks could be merged into one, further enhancing the communication capabilities.

### 9.3 MORE EXTENSIVE USE OF BARCODE

To make full use of AQAS, it is useful to have as many items bar coded as possible. Full and accurate bar coding of FAB routings, machines, and gages is important. Bar coding of gages will be especially important as the number of gages and gage types increase.

### 9.4 INSTALL AQAS AS A SHARED IMAGE

For the current implementation, the AQAS executable resides in TEL\$IMAGE, and is invoked by each user that runs AQAS. By invoking AQAS the user loads the AQAS executable into memory where it is run. For an implementation of five to ten users, there is no problem with this configuration.

Once AQAS is a full production system, with much more than ten users, it will be impractical to have each user load the entire image into a separate portion of memory. To avoid this, AQAS can be installed as a shared image, and each person using AQAS will be sharing the same section of memory, producing a considerable savings of VAX resources.

Installing AQAS as a shared image is a simple process consisting of relinking with the /shared option, installing the image at system start-up time, and creating a global symbol to run AQAS. This procedure is explained in detail in the AQAS System Manager's Guide.

### 9.5 PERFORM FREQUENT DATA BASE OPTIMIZATION DURING STARTUP

When AQAS becomes a full production system, data base use will increase dramatically as more and more data is added, deleted and modified each day. The database optimization procedure described in the AQAS System Manager's Guide uses the Ingres optimized facility to decrease data access time, resulting in improved AQAS performance. The utilization of the data base is enhanced when the optimizer knows about more different types of data. For example, in the

current system the database is optimized for five or six different part numbers. In the full production system there may be fifty or sixty different part numbers.

A way to increase the performance of the database when AQAS goes into full scale production is to make the OPTIMIZE AQAS procedure part of the nightly job which reads QOI data updates into the database. The database would then be optimized on a daily basis until such time as the data within the data base reaches a stable state.

## 9.6 TURN ON DATA BASE JOURNALLING AND CHECKPOINTS

As the use of AQAS increases, Teledyne CAE investment in the data contained in the data base will also increase. It will become important to protect that data through the use of journal and checkpoint files.

The AQAS System Manager should enable journaling on all AQAS tables. He/she should then arrange a schedule for taking check points on the data base. INGRES will create and maintain check point files of the data base and journal histories of how the database has changed since the last check point. Frequent checkpointing will reduce the disk space required to store journal files.

There are several issues involved in the location of and quota for journal and check point files. The System Manager should review chapters 2, 11, and 13 in the INGRES Database Administrator's Guide for more information before enabling check points and journaling.

## 9.7 MODIFY HELP TEXT AS USER NEEDS CHANGE

As the Teledyne CAE user community becomes familiar with AQAS, it may become evident that some portions of the AQAS on-line help provide more detail than is necessary, while other portions provide less detail than needed. If this occurs, the AQAS System Manager should edit the help text from the supervisor account.

## CHAPTER 10

### AQAS ENHANCEMENTS

This chapter deals with the recommended enhancements which became evident when the Phase II prototype was being designed and demonstrated. Enhancements are changes which require modification to AQAS code. Installation recommendations do not require code changes.

These enhancements are not part of Phase II but will be reviewed as part of the phase III implementation plan. These enhancements will require cost/benefit analysis and assessment of technical fit with TCAE's computer environment.

#### 10.1 MAINTAIN FIXED SPC LIMITS IN AQAS

Statistical process control detects changes in the production process based on product quality tests. Process changes are discovered when samples of measurements are outside of statistical limits.

As implemented, AQAS produces statistical graphs using two different sets of limits:

1. Calculated statistical limits based on the data retrieved from the data base.
2. Fixed limits based on the maximum and minimum on the QOI.

The latter option requires changing the QOI system to present the limits to the user.

An AQAS upgrade would calculate SPC limits, commit them to the data base (with identifying information such as who, why, etc.) and flag the user that fixed limits are available and should be used in lieu of calculated limits. No statistically based QOI changes would be necessary, and new QOI record keeping requirements would be avoided.

Finally, there would be two sets of limits available in AQAS, each with its own purpose:

1. QOI limits applied as the measure of part acceptance.
2. Statistical limits that evaluate changes in the manufacturing process relative to a specific period of production.

## 10.2 IMPLEMENT AN INTEGRATED REPORTING FACILITY

In the current AQAS system, users can produce a number of reports based on predefined data views. A command file invokes the INGRES REPORT facility to generate a report, and sends the report to the default printer. More views and reports can be added but this command file must be updated to do so.

It would be more convenient if users could access a reporting facility directly from the AQAS user interface. Several screens could be added to the Supervisor/Engineer branch of the user interface that would allow any user to select a report, specify parameters and print that report without leaving AQAS. Other screens would allow System Mangers to maintain the list of reports available.

## 10.3 DISPLAY USER CLASS ON ALL SCREENS

As more people access AQAS in multiple roles, acting first as an operator and second as an inspector at another operation, it will be helpful to display the current class.

## 10.4 MANAGE CONTEXT TO SPEED SCREEN MOVEMENT

As the load on AQAS increases, it will become important to reduce "unnecessary" access to the data base for two reasons. First, users may become impatient waiting for data to be loaded into screens which they may want to use only a small portion of. Second, data base access may slow down other more necessary access to the data base.

Two modifications to AQAS would be helpful as use increases. First, some screens could be modified so that data is not automatically loaded at start up, but instead is loaded when the user calls for it. Thus if the user needed access to the screen's menu, but not to its displayed data, he/she would not have to wait for that data to be loaded.

Second, AQAS could maintain a flag or flags in the database indicating the time of the last change for portions of the data. AQAS could look at this flag to determine if another user had modified the data before deciding to refresh the screen from the data base.

#### 10.5 INSTALL DATA BASE LOCK ERROR HANDLING/TIMEOUT

As the number of people using AQAS at one time increases, people will have to wait for access to data more frequently. AQAS could be modified to ask users if they wish to wait or try again later. The time that AQAS waits before informing the user of the delay could be a system or process parameter.

In addition, when the database is locked for longer periods of time, such as for QOI download, AQAS could inform the user of an estimated availability time.

#### 10.6 SHARE GAGE PORT HARDWARE WITH SEVERAL TERMINALS

AQAS is a user interface system. Actions do not occur independently of user initiation. The advantage of this type of system is that the user has control of the software and the software design is simplified, but there is a tradeoff. Many system resources are tied to a single user and cannot be effectively shared.

Independent device communication without a user interface allows device sharing and/or automated operation. AQAS could be modified to allow a single gaging station to be used by multiple terminals. A user-independent, or detached, process communicates with the gage device and makes measurements available for multiple user processes. This reduces investment in gage port hardware and special gages that have output capability.

## 10.7 PARTITION DATA FOR NETWORKED IMPLEMENTATION

As AQAS moves from a demonstration phase to full production use, the demand for access to the database will increase. One technique for managing that demand will be to install AQAS on multiple machines and/or with multiple databases. It would be both natural and useful to divide the data along part numbers. This would reduce the contention for use of data tables except where such contention is natural and unavoidable.

There may be a need for sharing data between these separate systems. If so, AQAS would have to be enhanced to support that data transfer.

## 10.8 ADD CAUSE CODES AND CAUSE CODE ANALYSIS

When a Quality Supervisor/Engineer has determined that a measurement is unusable for process control due to assignable cause, he/she goes to the Sample Data screen and indicates that fact to AQAS. AQAS then skips that measurement in performing its process control calculations for graphs and displays.

To further add to the information known about the measurement, the user could input a cause code to AQAS rather than a simple use/don't use flag. Measurement data could then be analyzed by cause code. A Pareto Graph divided by cause code would be a useful tool. Producing a control chart for a specific cause code could also indicate more about the specific problem. If, for example, a number of measurements were determined to be out of tolerance due to the use of the wrong machine tool, a control chart of just these measurements might show a tight distribution around a mean way above tolerance, indicating that the process is in control, but the incorrect tools caused bad parts to be manufactured. In this way the affect of each known problem with the process can be isolated and examined.

Cause codes can also be assigned to attribute data, and used for analysis of those characteristics.

## 10.9 PERFORM NONCONFORMANCE STATISTICAL ANALYSIS

As use of AQAS grows, the quantity of nonconformances entered into the data base will increase. The ability to thoroughly analyze these problems as a separate data group can be very valuable.

Advanced statistical analysis, correlation analysis, scatter diagrams, and many other techniques would enhance the understanding and resolution of nonconformances. The analysis would focus on prevention through better understanding of the problems.

Clearly a link to an external statistical package would be a first cut at determining what analysis is appropriate. Experience with the external package will help TCAE decide which analysis should be included as part of the AQAS user interface.

## 10.10 SHARE DATA WITH EXTERNAL STATISTICAL PACKAGE

AQAS provides Quality Engineers and Supervisors with the capability to produce X-BAR-R, X-BAR-SIGMA, HISTOGRAM, PRECONTROL, MOVING X-BAR-R and Process Performance displays. In the future, it would be useful to have AQAS measurement data available to an external statistical package such as SAS or RS/1 for more extensive analysis.

In order to do this, a module must be added to AQAS which will read selected data from the data base and convert it into the file formats required by such an external system. In addition, it may be necessary to transfer these files from the MicroVAX to another machine, such as the corporate IBM mainframe, or an IBM PC, if the external package were to run on one of these machines.

## 10.11 ALLOW MODIFICATION TO AQAS QOI

Timely updating of QOI data is vital to the success of AQAS. Currently, AQAS depends on QOI data downloaded from a separate system. As a result, it may take a day or longer to make a permanent change to the QOI.

This delay could be reduced by adding direct QOI editing capabilities to AQAS. AQAS would maintain the definitive versions of the QOI for its part numbers. There would be no need for Quality Engineers to authorize special versions of the QOI in anticipation of new versions being downloaded. Instead, they would simply update the definitive QOI.

#### 10.12 DEVELOP AN AQAS GAGE CALIBRATION SYSTEM

Timely updating of the Gage Calibration Table is important to the success of AQAS. Currently, AQAS depends on this data being downloaded from a separate system. Consequently, this data can become out-of-date.

If AQAS functionality were expanded to include creating and maintaining a definitive Gage Calibration Table, this delay would be eliminated. The shop floor would have accurate calibration data.

#### 10.13 INCLUDE SHOP NONCONFORMANCE HANDLING

AQAS reports nonconformances when they occur and insures that the lot does not continue on to the next operation until the nonconformances are resolved. When the nonconformances are resolved, the Quality Supervisor/Engineer reports what he/she did to resolve the nonconformance and AQAS records that resolution, clears the nonconformance and releases the lot.

This basic handling of nonconformances can be enhanced in several ways:

- o Currently, nonconformances can be created only during ongoing QOI operations. The system can be enhanced to allow entry of nonconformances at any time.
- o General workmanship nonconformances are lumped under one character code, "0000". These could be subdivided into different types and described in more detail. See section 5.1 on a visual inspection system for a detailed description of general workmanship nonconformances.
- o Instead of only recording the resolution of the nonconformance, AQAS could track the parts through repair or rework, back into production.



- o Cause codes can be assigned when nonconformances are reported (see section 4.9 on Cause Codes). The recording of cause codes would enable AQAS to calculate and report recurrency rates.
- o More displays could be added to AQAS showing nonconformances currently undergoing rework of repair.

In general, more useful information could be obtained about nonconformances and that information used for analysis and reports.

#### 10.14 ACCOMMODATE MULTIPLE RESULTS AND GRAPHIC LAYOUT

Presently, AQAS can only receive and record a single result for an individual characteristic. In many cases, that characteristic may actually consist of several results, such as a bolt hole circle of a dozen holes, four of which are measured.

AQAS could be enhanced to allow the user not only to input several values for a single characteristic, but also to indicate exactly which physical feature on the part each measurement corresponds to. A convenient way to do this is to present a graphic illustration of the part to the user, and allow him/her to indicate which features he/she measured. This can be done either with a graphic input device such as a mouse or trackball or through the keyboard using arrow keys or numbers. When the user selects the feature, it can be highlighted on the graphic display, indicating which one he has chosen.

AQAS would then have access to all the measurements for analysis, instead of just the worst case measurement.

#### 10.15 IMPROVE ATTRIBUTE STATISTICAL/GRAPHIC ANALYSIS

If AQAS is modified to handle diverse types of attribute data, such as defect counts and locations, or cause assignment, it will be important to add the ability to analyze that data appropriately. Capability to produce U-charts, C-charts, P-charts, nP-charts, and summary analyses should be added to AQAS.

#### 10.16 UPGRADE AND ENHANCE THE USER INTERFACE

The current AQAS system is designed to be used along with the paper routing system which exists in the factory today. Eventually, that system will also be computerized and AQAS can take advantage of the data available.

One way to do that would be in the form of pop-up selection windows. For example, in the Enter Inspection Information screen, the user types (or wands) in all the information about the lot he is about to inspect. If AQAS had information available about all the production lots on the floor, the user could pop-up a window over the current screen listing all these lots. He could then select one from that list to begin work. The same is true for operation, work center, etc.

This feature would be particularly useful in the analysis branch of the user interface, where a user might want to graph various operations or characteristics. Instead of looking up each characteristic on the QOI display, he/she could pop-up a section window showing the characteristics along with other useful information, such as appraisal code, and select one of these.

This enhancement to the system would be a useful but complicated one because the Ingres forms package does not provide windowing capability. The entire AQAS application would have to be rewritten using a different forms package, such as Digital's FMS.

#### 10.17 DELINEATE AUTOMATIC AND MANUAL RESULTS

A useful enhancement to the AQAS System would be to keep track of what the source of a measurement was: automatic analog or digital gage, CMM, CNC, or manual input. This data could then be used for analysis, and could be displayed to the user on the data collection screens.

In the same manner, some restrictions could be made on data input through automatic devices. Data originating from an automatic device could be either accepted or rejected, but not manually edited. In the present system it is not possible to implement this type of control because AQAS does not keep track of the source of a measurement.

## APPENDIX A

### GLOSSARY

ITEM	DESCRIPTION
ASCII	American Standard Code for Information Interchange. A coding scheme for alphanumerics and punctuation that is decipherable by a computer. In this scheme, every character is represented by a number.
AQAS	Automated Quality Assurance System.
Gage, Analog	A measurement device that produces a single, continuous reading of what it is measuring. Direct interpretation into ASCII is not possible, but a conversion against a known analog standard may be.
Gage, Digital	A measurement device that produces a discrete measurement result that can be directly interpreted into ASCII.
MRB	Material Review Board.
NMR Number	Non-conformance Material Review Number. An NMR number is assigned to a non-conformance when it is escalated to a MRB status.
OSO	Operation Sequence Outline. Documentation pertaining to the procedures for a specific part number/operation.
Plant System	Plant system refers to the other systems at the Teledyne plant, outside AQAS. In Toledo, the plant system is the IBM 3033.
PMR	Preliminary Material Review

PNO

Part Number/Operation abbreviation.

QOI

Quality Operation Instructions. The term QOI can be used to refer to both a system on the plant computer, and to AQAS' version of the QOI system.

QWI

Quality Work Instructions. Teledyne's documentation relating to quality operations and procedures.

## APPENDIX B

### TECHNOLOGY MODERNIZATION SUGGESTIONS

The following potential projects fit very well with AQAS while others are entirely new directions for CIM implementation. These projects should be considered within an overall CIM strategy.

#### B.1 VISUAL NONCONFORMANCE WORK STATION

An integrated visual nonconformance system could enable TCAE to perform different types of analysis on general workmanship and other attribute data. Extensive visual inspections and FPI inspections are performed on parts at various stages of production including receiving and final inspection.

##### B.1.1 Defect Codes

To support general visual inspections, a number of defect codes can be created to precisely describe the type of defect encountered. Since these codes are exact descriptions, they can be arranged in a tree structure, and a user guided through a series of multiple choice selection screens until he/she reaches the exact description of the defect. An example would be:

First level:

- \* General Workmanship Problems
- \* FPI
- \* . . .

After selecting General Workmanship, the following choices might appear:

- \* Paint problems
- \* Scratches and scrapes
- \* Dents
- \* Pits and holes
- \* . . .

Finally, after selecting the category of problem, the user would get a detailed listing of choices:

- \* Paint discoloration
- \* Paint blotched
- \* Paint flaking
- \* Paint chipped
- \* Paint spots missed
- \* Paint faded
- \* Wrong color paint
- \* . . .

This list of descriptions can be user-maintainable, so that users can add codes when they find the need and delete ones they never use. An "other" category can be provided for unique problems.

Recording a detailed description of the problem such as this is not only useful in diagnosing and fixing it, but also for running analyses on what types of problems are occurring and how often they occur.

#### B.1.2 Graphic Indication of Nonconformance Location

In addition to indicating what type of problem has occurred, it is important to indicate where on the part the problem lies. This is most conveniently done graphically. A sketch of the part is displayed to the user and he/she indicates

the exact location of the defect. This can be done with a graphic input device such as a mouse or trackball, or by breaking the sketch down into grids and allowing the user to input the grid number. Again, this information can be used to analyze specific types of problems on parts.

### B.1.3 Fluorescent Penetrant Inspection (FPI)

A useful application of a visual inspection workstation is FPI. In the FPI booth, the inspector has two problems in recording a defect: usually he/she is using both hands to examine the parts, and the booth is darkened so that typing on a keyboard would be difficult. To implement the visual workstation described in the sections above, a voice input device can be added to the terminal. This would consist of a microphone which the inspector wears around his neck, providing alternate input - similar to a mouse or trackball. The inspector can make his selection of codes through spoken commands, as well as give the grid location of the defect on the sketch. The entire inspection and recording of defects can be performed without leaving the booth and without putting the part down.

## B.2 DESIGN FOR RECEIVING INSPECTION

AQAS first learns about parts when they are introduced as production lots and then begin their first QOI operation. To extend the traceability of these parts, and make more data available for analysis, a receiving inspection function could be added to AQAS to extend the history of these parts back to the time they were received into the plant.

At receiving, parts are grouped by P.O. number because they have not yet been placed in production lots. An integrated receiving inspection system could record this fact, enabling AQAS to link each individual part back to its original P.O. number at any time. This can provide a link back to the supplier, and any other information produced during receiving inspection, such as a Supplier Variation Report (SVR) number. With this information, control charts, histograms, Pareto graphs and database reports can be produced based on a particular supplier.

The receiving inspection itself can also be automated, and the data used for analysis like any QOI operation. Since receiving inspection almost always involves a comprehensive visual inspection, the visual inspection system described above would be a valuable tool to incorporate into any receiving inspection system.

### B.3 INCORPORATE FINAL INSPECTION MODULE

Final inspection is the last QOI operation performed on a part. It includes verification of all the paperwork associated with the part, a comprehensive visual inspection of the part, and possibly other types of inspection as well.

Currently, AQAS does not distinguish final inspection from other QOI operations. An integrated final inspection system would allow inspectors to efficiently use the data in AQAS to verify "all the paperwork" associated with that lot. A final inspection system would consist of a computerized checklist including the following checks:

1. Operations performed are compared to the QOI data. Any discrepancies are highlighted.
2. A summary of all nonconformances which occurred within the lot and their resolutions are displayed. At this time any nonconformances which have been deferred past final inspection can be activated. In the current system AQAS has no way of knowing if nonconformances are deferred to an operation which will never be reached.
3. A summary of all parts which were sent off to MRB is displayed.
4. A comprehensive visual inspection of the parts is performed. See section 5.1 for a description of this visual inspection system.
5. Final buyoff of the parts is recorded. Since AQAS now knows that the parts are no longer in production, the data can be marked for archiving. The next time the archive procedure is run, this data can be stored to tape without waiting for the archive period to expire.

At this time a final report on the lot summarizing the data described in the checklist above and showing the buyoff measurements on serialized parts could be produced and included along with inspector approval of the parts.

The final inspector also has all other analysis tools which AQAS provides at his/her disposal and is therefore alerted to potential problems and better equipped to make a judgment on final buyoff of the parts.

### B.4 MACHINE CALIBRATION SYSTEM

As each inspection starts, AQAS checks the calibration date for each gage to determine if it can be used.



AQAS could be extended to check that the machine being used is in calibration. If the calibration date has passed, AQAS would inform the operator of this condition. AQAS could also have a machine and gage calibration screen to inform engineers of upcoming calibration requirements.

This machine calibration system could be integrated with AQAS, with changes made directly to the AQAS calibration table, or implemented as a separate system interfacing with AQAS via file transfer as the QOI system is connected today.

#### B.5 SHOP FLOOR GRAPHIC DISPLAY OF SKETCHES

With AQAS, the only paperwork required for a quality related operation is the Quality Operation Sketch (QOS). This paperwork could be replaced by a graphical interface and display. A library of Quality Operation Sketches could be maintained on the MicroVAX. This library could be built on the VAX 785 and then downloaded to the MicroVAX for release to production. Since the VAX 785 contains the CAD/CAM system, this makes a natural fit.

The DI3000 package has a built-in "metafile" system that is used to display graphics of this type. Some CAD/CAM systems can produce this metafile, or an IGES standard file can be converted to metafile format. The MicroVAX would store and access the metafiles.

#### B.6 SHOP FLOOR PRODUCTION CONTROL

AQAS is concerned with operations that have a quality component, that is, ones with QOI data. AQAS does not have access to the full routing or to the status of operations that have no quality component.

It may be useful to enhance AQAS functionality with tracking of all production and quality operations. This would allow AQAS to guarantee full compliance to routing requirements for operations. Users would be alerted if operations were performed out of sequence. The full history of a production lot would be available in AQAS. Order status would be known within AQAS at all times.

#### B.7 ASSEMBLY TRACKING

AQAS allows users to record what components have been included in each serialized part.